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DRAFT INFORMATION ON TRAINING, USE AND MAINTENANCE OF EXPLOSIVES DETECTOR DOGS

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Franklin Institute Research Laboratories

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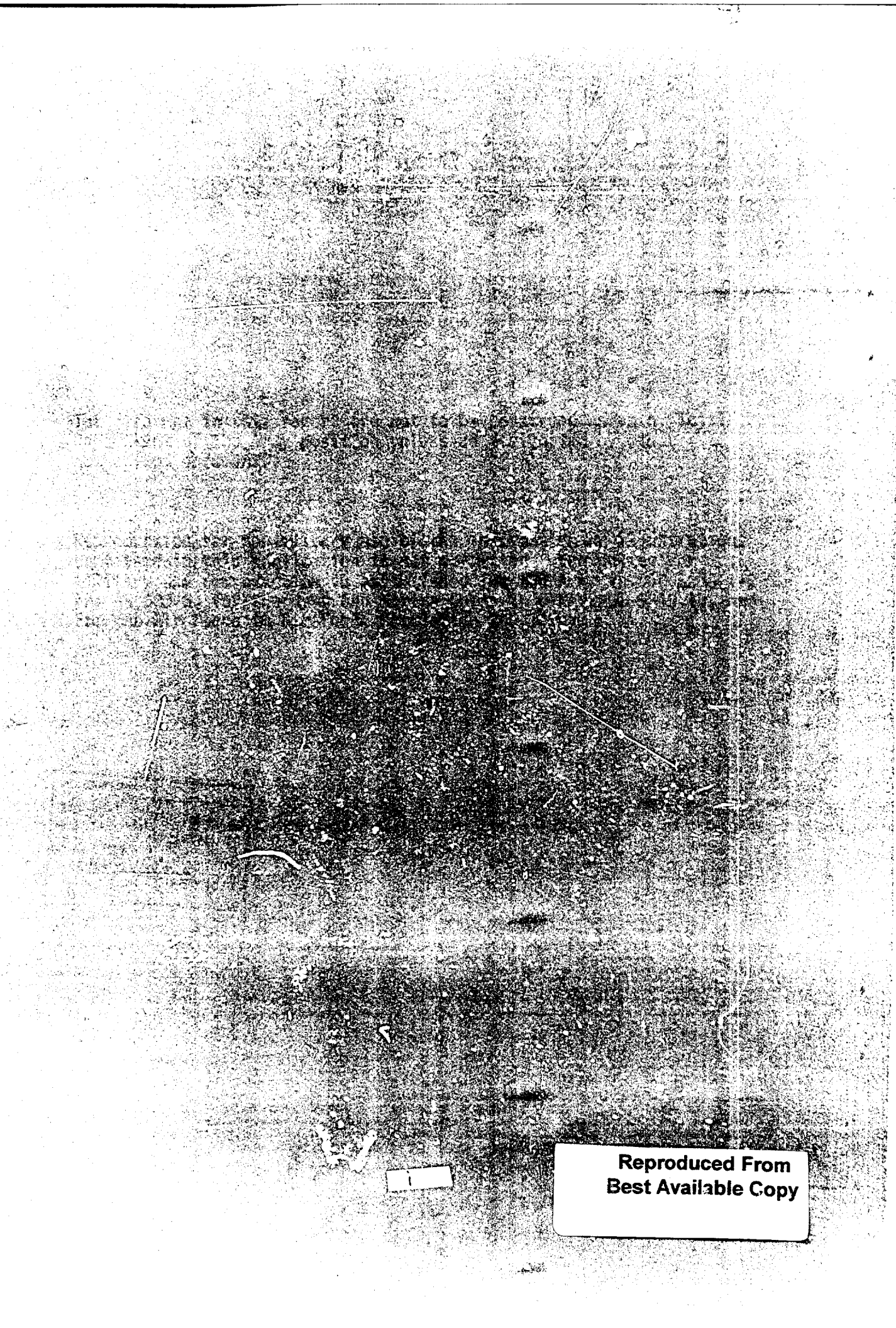

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Procedures for training dogs to detect explosives are described in detail. Food is used as the primary reinforcer to establish the desired behaviors rather than the traditional method of praise/petting/punishment. Beginning with simple odor discrimination, the training progresses through easy stages to complex search/detection in realistic settings. Concepts and strategies for conducting operational bomb searches in buildings are described.

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FOREWORD

The information presented in this report includes much that was originally developed by Mr. Ray Phillips at the University of Mississippi for the Land Warfare Laboratory under Contract No. DAAD05-70-C-0347 and reported in LWL Technical Memorandum No. LWL-CR-01B70, October 1971. The original material was expanded and to some extent modified by LTC Robert Lomax (Ret.) as a result of experience by personnel of the Military Dog Detachment of the US Army Infantry School, Fort Benning, GA, in applying the procedures in a military setting. Mr. Sanford Meschkow of the Franklin Institute Research Laboratories of Philadelphia, PA, worked with LTC Lomax in organizing and collating the material in a format that lends itself to consideration as a draft proposed Army Training Manual. Max Krauss of the U. S. Army Land Warfare Laboratory was responsible for final technical editing.

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INTRODUCTION

Purpose and Scope

This report will serve as a guide for personnel charged with the training of dogs utilized to detect the presence of explosives. It includes guidance concerning the selection of animals, pretraining, testing, maintaining proficiency, instructions for the dog handler and employment techniques. A portion of this report is devoted to "expected training problems."

It is recommended that this entire report be read prior to beginning actual training. It is also recommended that the training program be conducted by qualified dog trainer personnel and that all dogs be pretrained in basic obedience.

The direct reporting by the individual user of errors, omissions, and recommendations for improving this report is authorized and encouraged. DA Form 2028 will be used for reporting the improvements. DA Forms 2028 will be completed by the individual using the report and forwarded direct to: US Army Troop Support Command, ATTN: AMSTS-RE, 4300 Goodfellow Blvd, St. Louis, MO 63120.

Missions and Responsibilities

Instructors - The Military Dog Detachment of the U. S. Army Infantry School at Fort Benning, GA, is responsible for the initial training of instructor and handler personnel in the scout dog, mine/tunnel dog and tracker dog training programs. The dog training detachment is responsible for the conditioning and training of military dogs and also provides consultant service to using agencies.

Procurement - The DOD Dog Center, Lackland Air Force Base, TX, is responsible for procuring dogs and shipping them to the training centers.

Command Responsibility - Commanders are responsible for the proper employment, handling, care and continued training of military dogs assigned to their command.

THE BOMBING THREAT

Background

The prospective trainers should be fully cognizant of the importance of the explosives detection function and the scope of the bomb threat problem. From the handling of reports of bomb threats in the news media, it is easy to assume the majority of bomb threats are the results of crank calls and that very few live bombs are actually involved. However, according to the statistics assembled by the National Bomb Data Center*, the incidence of live explosives actually placed in the locations of bomb threats clearly constitutes a major hazard to equipment and personnel.

Bombing Statistics

During the calendar year 1972, 1,962 bombing incidents involving 2,613 devices were recorded by the National Bomb Data Center. This represented an average of over seven incidents per day for the year. The highlights of the report are summarized below:

a. In only 30 percent of the incidents did one or more devices function.

b. A total of 41 percent of the incidents involved explosive devices.

c. Cities with over 250,000 people reported the greatest number of incidents per capita.

d. During the reporting period, 25 deaths and 176 injuries were reported. Of these, 1 death and 8 injuries were sustained by police, 8 deaths and 42 injuries by bombing suspects, and 12 deaths and 38 injuries by innocent civilians. In only 38 cases were the intended victims injured; over 43 percent of the injured were innocent bystanders.

e. These incidents involved $7,991,815 in property damage.

Targets

The most common targets were residences, totaling 573 incidents. A total of 488 incidents involved private homes (See Figure 1).

The next most common targets were commercial operations, totaling 511 incidents. A total of 410 of these incidents involved stores and shops.

The next most common targets were vehicles, involved in 240 incidents, and educational facilities, involved in 188 incidents. Military facilities were

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* The National Bomb Data Center is a program established in July 1970 by the International Association of Chiefs of Police and now funded by the Law Enforcement Assistance Administration of the U.S. Department of Justice.

Figure 1. Residences Were the Most Frequent Targets for Bombing Incidents in 1972.

involved in 60 incidents, and public buildings (court houses, hospitals, post offices, etc.) were involved in 34 incidents.

Explosives

The explosive composition of bombs is no longer reported. However, in the 1970 reporting period the explosive used was identified in less than 50 percent of the cases.

Of those bombs where the explosive was identified, nonmilitary dynamite accounted for over 60 percent of the bombs. Black powder was identified in about 11 percent of the bombs and smokeless powder in 6 percent.

Military explosives were found in only 4 percent of the reported bombs. Composition C-3 was identified in half of those cases.

FOOD REWARD METHOD

General

There are two basic methods used in the training of military dogs, the praise-punishment and the food-reward methods. Both methods make use of the principle of reward for the desired performance and punishment for nonperformance or misbehavior.

Praise-Punishment Method - This is the traditional method used by animal trainers. Simply stated, when the dog successfully performs some task, it is rewarded by praise and petting. When it fails to perform, or if it misbehaves, it is punished by verbal disapproval and physical discomfort or mild pain.

Food Reward Method - This method is relatively new to military dog training. In this method, the animal is conditioned to associate the performance of a task or the presence of a particular object or odor with the appearance of food. The dog learns that performing tasks such as locating an object or scent will bring food. Failure to perform a given learned task does not bring physical punishment, but results in food being withheld. This may seem overly simple, but since food is usually eagerly sought after by a dog, the method is effective. This method is effectively used in training military dogs that must perform a large variety of unrelated tasks or where the task to be performed is complex or difficult.

Training Food

Reward Food - This is food given to reinforce desired behavior (reward for correct performance). For this purpose a commercially-prepared soft-moist dog food in the form of cubes or large pellets is used (Figure 2). The amount given is generally one cube. The cubes must be easily handled and must not crumble when handled. Each handler will require one or two pounds of training food for his dog each training day.

Ration Food - At the completion of the last work session of the day, the dog is given the remainder (if any) of its prescribed daily ration of training food plus a meat-base canned dog food. If the dog has not performed well that day, the balance of its ration can be withheld to insure the dog's being hungry for the next day's training. On nonworking days (weekends) the dog's daily ration should be one can of commercial dog food and 1/2 can of MSD*. THE DOG IS NEVER GIVEN FREE FOOD DURING THE WORK SESSION.

Veterinary Supervision

Close coordination with and supervision by the station veterinarian is necessary when using the food-reward method. Due to variations in motivation and appetite, some dogs initially will lose weight during training. Close coordination with veterinary personnel will prevent weight loss to the point where the animal's health is endangered. If a dog is unable to learn quickly enough to earn its minimum daily ration, it should be eliminated from training.

* MSD - Maximum Stress Diet: A medicated, low bulk, high vitamin and protein dog diet with hookworm suppressant used by the Armed Forces.

Figure 2. Food Pellets or Cubes for Rewards During Training Sessions.

ANIMAL SELECTION

Desired Characteristics

Breed and Temperament - The selection of dogs to be trained for explosives detection is of critical importance. Either German Shepherds or Labrador Retrievers are preferred for this purpose; dogs of both of these breeds are available from the Department of Defense Dog Center. Individual dogs selected for explosives detection training should show inquisitiveness, a certain degree of aggressiveness and adaptability. These qualities can be judged by applying the following general criteria:

a. Inquisitiveness. Dogs selected should have a desire to explore their environment. They should especially display an apparent interest in odors, as evidenced by sniffing of new objects.

b. Aggressiveness. Dogs should not appear timid or shy of people; neither should they appear to be unfriendly. They should be responsive to petting and praise even from strangers. Dogs of even, friendly, somewhat outgoing temperament are most desirable.

c. Adaptability. Dogs should adapt readily to new situations and environments. They should tolerate strangers and accept a new handler with little change in behavior performance.

Observation Period - A dog in new surroundings may require an adjustment period and should not be judged too quickly. Normally an observation period of 14 days will be needed to determine what a dog's behavior will be like over a more extended period. During this period the dog's personality and disposition can be observed and a decision made as to retaining or eliminating the dog from the program.

Number of Dogs Selected - In selecting dogs for training, more than twice as many should be selected initially as will actually be required. For example, if the requirement is for ten bomb detection dogs, it is suggested that twenty-five dogs be accepted initially. From the twenty-five dogs selected, it is anticipated that 10 to 15 will be eliminated during training. If fewer dogs are needed than successfully complete the training, the best dogs can be selected to fill the requirement.

BASIC OLFACTORY TRAINING

General

The presentation of rewards or punishment, whether with dogs or humans, serves to change the behavior of the animal. When a reward is presented just after a dog makes a particular response, the likelihood of that response occurring again is increased. The reward then, is said to "reinforce" that response. The reverse is true of the administration of punishment. Punishment thus, is often called "negative reinforcement." It is easy to see how certain behaviors can be modified so that they are more or less likely to occur simply by presenting rewards and punishment following certain actions.

When a dog first smells an explosive, it may sniff it and exhibit curiosity, but the odor has little additional effect on its behavior. However, if every time it sniffs at a sample explosive odor it hears GOOD and is given food, and if along with this behavior the dog is gently urged into a sitting position, which likewise brings on GOOD and food, before long the dog will have learned to sit when it smells that particular odor. The trainer must be careful not to reinforce sitting to any odors other than the given one. As a result of this sort of differential reinforcement a dog will learn to sit when it is presented with certain odors (explosives) and not to respond to any other odors.

In the final stages of training, dogs will learn to search actively for the odor of particular explosives that result in the delivery of food. A major point to remember is that to maintain a dog's desired behavior, it is necessary to reinforce this behavior. This does not mean that the dog has to be reinforced on every trial, but it does need to have frequent reinforcement when it responds to the correct odors.

If a dog goes for long periods of time without reinforcement or if the reinforcement is given at the wrong time, the dog's behavior will break down and it will fail to sit at the correct odor, sit more or less indiscriminately, or become erratic in its search activity.

At no time is physical abuse used to correct the dog for undesirable behavior. A stern NO, during or immediately following (not over three seconds) the undesired behavior, will generally serve to reduce the chance of the behavior recurring. It should be emphasized that physical punishment is not given during training sessions. Punishment is not an effective way to train a detector dog, and will, in fact, be harmful to its progress. In general, the effect of punishment is to induce fear and this tends to disrupt desirable behaviors. A fearful dog will not make a good detector dog.

Spoken commands, such as GOOD DOG and NO, have no meaning to the dog except in relation to the events which follow these commands. If pleasant consequences follow the word GOOD, then eventually the word GOOD becomes rewarding to the dog. With proper training the word GOOD will continue to be rewarding to the dog even if it is only occasionally followed by food and petting. The same is true for NO when used as punishment. Granted a very loud NO may itself be punishing because of its startling effect; its effectiveness as a punishment, however, results primarily because it is followed by removal from a

potentially rewarding situation and by withholding of food. If an undesired behavior occurs and is immediately followed by the word NO, that particular behavior will be less likely to recur. If the verbal NO is never followed by some unpleasant consequences, it will gradually lose its effectiveness in controlling the animal's behavior.

No two dogs will learn at the same rate; thus all training must be programmed to suit each individual dog. THE TRAINING PROGRAM INVOLVES THE ASSIMILATION OF NEW BEHAVIORS, EACH NEW BEHAVIOR BEING DEPENDENT UPON THOSE PREVIOUSLY LEARNED. If a dog is slow in learning a particular task, it is essential that it be given additional practice at this task before it is introduced to the next training task. If a dog is pushed into new learning situations before it has mastered a more elementary one, it probably will not be able to learn the new task. Do not make the mistake of rushing the dog. Be certain it has mastered one task before moving to the next. Any time the dog is performing poorly, it is essential to revert to a simpler task; once it is performing well, gradually progress to the more complex task. If the dog continues to perform poorly on the simpler task, training should be temporarily discontinued.

Many dog trainers make use of the choke collar as the primary tool in training dogs for various tasks. This practice is not recommended for the training of detector dogs. A jerk on the choke collar may only be used under the following conditions: (1) the dog bites or attempts to bite another animal or human; (2) the dog growls at a person or at another dog. To correct other unwanted behaviors, such as sitting when no explosive is present, a NO followed by removal of the dog from the position without being given a food pellet is the only permissable negative reinforcement.

The Reinforcer Word "Good" (or "Good Dog")

The word GOOD (or GOOD DOG) is used throughout training as a secondary reinforcer to inform the dog that it has performed an expected task properly, or in slightly different terms, to reinforce the occurrence of desired actions or behavior. The effectiveness of the word GOOD as a reinforcer is derived from its association with food, the primary reinforcer. Briefly, GOOD is spoken in a low-to-moderate tone of voice, immediately preceding the presentation of food following the dog's performance of the desired behavior or action. The correct procedure for conditioning the dog to respond to GOOD is described in this section.

Conditioning of the Word GOOD

Each handler should wear his apron filled with training food. The apron is worn at the waist, in front of or on the right side (Figure 3). The handler will take his dog into a pen, room or any enclosed area and remove the leash. The dog is allowed to roam about the area for a few minutes to accustom itself to its surroundings. The handler then begins the conditioning to the word GOOD.

Whenever the dog is near the handler, and especially if it is looking at him, the handler says GOOD; one-half second later he takes a cube of food from his apron and places it in his dog's mouth (Figure 4).

Figure 3. Apron for Training Food Pellets or Cubes.

Figure 4. Conditioning of GOOD. The Dog is Fed.

Timing is critical during this and all future stages of conditioning. The procedure must always be: GOOD, one-half second pause, appearance of food. The handler must not give the dog any clue or signal, such as reaching toward the apron or bending over, before the word GOOD is said. This procedure is continued for several trials, until the dog starts watching its handler and waiting for food, or otherwise exhibits what is termed "begging behavior." The end result sought by the trainer is for the dog to become conditioned to the word GOOD. When the handler is sure his dog is responding to GOOD, he can then use GOOD to reinforce desired behaviors as they appear. This training process is known as "shaping" behavior.*

Basic Odor Discrimination

Olfactory training consists of two phases. The first phase can, if necessary, be conducted by one person. The second phase can be conducted more efficiently by two persons. In the first phase of olfactory training the objective is to establish a conditioned response to a training odor (dynamite). This means that the dog will begin to salivate and perhaps wag its tail when the odor of dynamite is presented, i.e., the odor becomes a signal that praise and food are to follow. The result of this conditioning procedure is to make reception of the odor rewarding to the animal. The association between the odor, food and praise will be established through repeatedly letting the dog smell the odor and then immediately giving it food and praise.

Materials used in this phase of training are: (1) Six identical screw-top four ounce glass jars, each with a 1/4 inch hole in the cap; (2) for each jar, a 2 x 6 wooden board, 26 to 48 inches long, with three holes in which to mount the jars; and (3) approximately two level teaspoons of dynamite for each S+ jar.** The following discussion will use the symbol S+ to refer to the odor to be detected and S- will indicate the absence of that odor.

The mechanics of the training procedure are straightforward. During Phase I the dog should be tethered and the S+ and S- stimuli brought one at a time to approximately 10 to 15 inches from the dog. A single trial then, consists of placing either the S+ or S- simulus under the dog's nose (Figure 5).

As the dog breathes, it will receive the S+ or S- odor. On S+ trials the jar is placed under the dog's nose and the handler then says GOOD DOG and feeds and pets the dog (Figure 6).

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* Particular actions or behavior of an animal can be "shaped" by reinforcing them as they occur by saying GOOD, which should be followed about 1/2 second later by presentation of a food pellet. For example, to shape "sample jar inspection," the dog is placed in a situation in which he has free access to a sample jar. Any movement of the dog toward the jar is reinforced with GOOD and food; the dog quickly learns that going directly to the jar is the quickest way to earn these "rewards."

** Either commercial ammonium nitrate dynamite or straight nitroglycerin dynamite may be utilized; however, once a type has been selected, it should not be varied. Military dynamite is not recommended for use in early training.

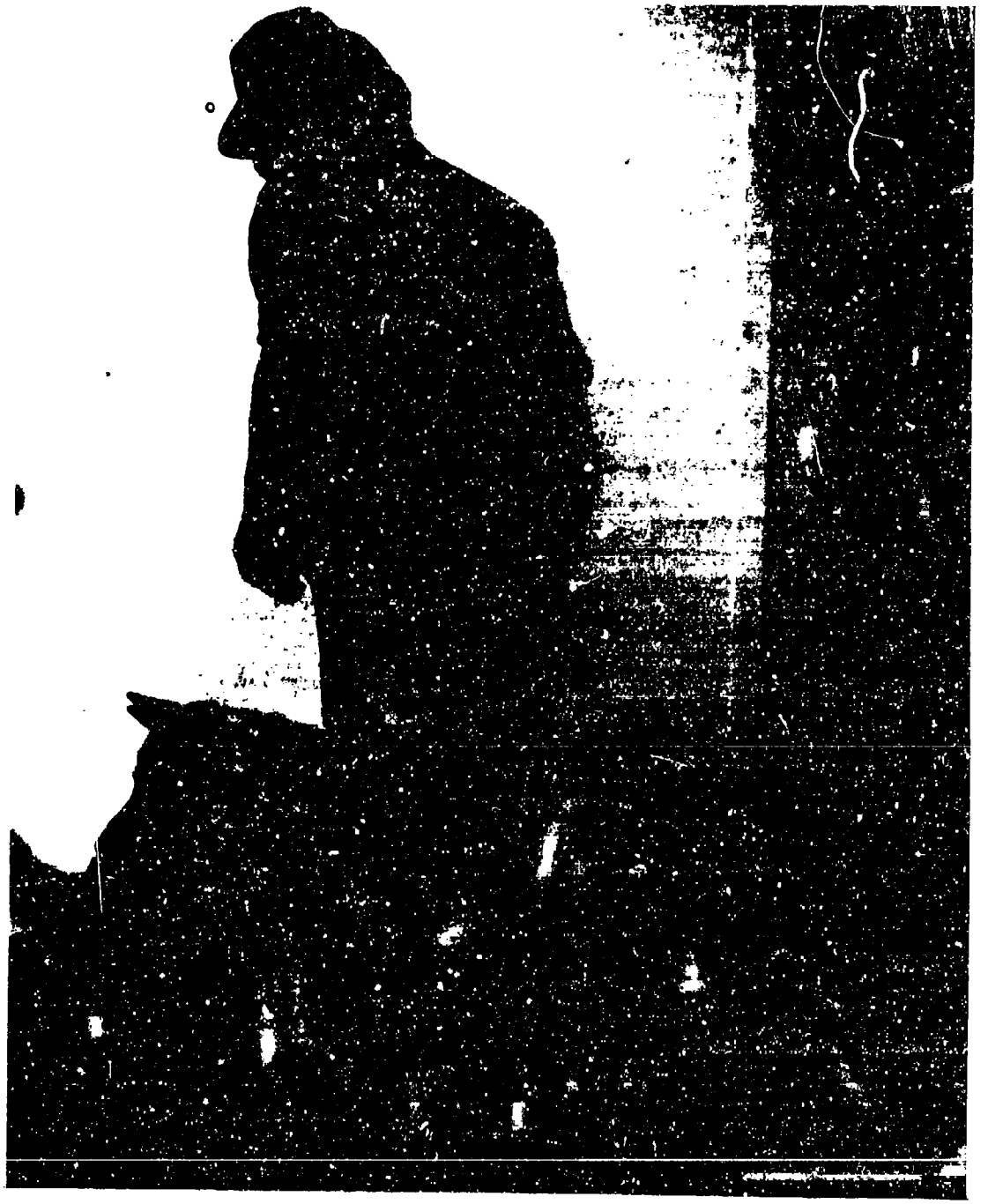


Figure 5. Phase I Scent Association. An S+ or S- Jar is Placed Under the Dog's Nose.

Figure 6. Phase I Scent Association. Dog Being Petted and Praised.

On S- trials the jar is simply removed. Food and petting are not given on S- trials.

Following presentation of a jar, with reinforcement for S+ and no reinforcement for S-, the handler turns, moves to the place where the S+ and S- stimuli are kept and obtains the appropriate jar for the next trial. If an additional person is available, he can tell the Handler whether the trial is an S+ or an S- trial and can record each trial on the data sheet. Otherwise, the handler can mark the data sheet and note the condition for the next trial (Figure 7).

The schedule of S+ and S- presentations during Phase I is one of a random distribution with progressively fewer S+ in relation to S- presentations. The schedule begins with a ratio of two S+ stimuli for each S- and progresses through a ratio of 10 S- stimuli for each S+.

There are four blocks of trials at each ratio. This schedule results in 44 reinforcements in 197 trials. Broken down, the number of reinforcements and number of trials at each ratio are as follows:

Reinforcements	in	Trials	at	Ratio
8		12		2-1
4		8		1-1
4		12		1-2
4		20		1-4
4		24		1-5
4		28		1-6
4		32		1-7
4		36		1-8
4		40		1-9
TOTALS 44		196		

Figure 7 consists of a sample data sheet which has been filled in and can be used as the schedule to follow. The trials in Phase I can be given in one day or can be spread over two days. It is suggested that if half the trials are given on each of two separate days, on the first day the ratios 2-1 through 1-4 should be conducted and on the second day the ratios 1-4 should be repeated, followed by the progression to 1-9.

The procedure in Phase II is almost identical to that of Phase I. The only difference is that instead of bringing the S+ or S- jar to the dog, as was the case in Phase I, the handler walks the dog to the board and jar assembly, which is held horizontally by a second person (Figure 8).

The same schedule is followed in Phase II as was followed in Phase I.

Data Sheets

The data sheets should be made out before beginning the training session and should follow the general format of the sample data sheets. The schedule of reinforcements proceeds across the page from left to right, going from one ratio to the next. A plus (+) in a column means that on that trial an S+

SCENT ASSOCIATION DATA SHEET

TRAINER: LOMAX DOG: BUTCH

SCENT: COMMERCIAL AMMONIUM NITRATE DYNAMITE DATE: MAY 16, 1973

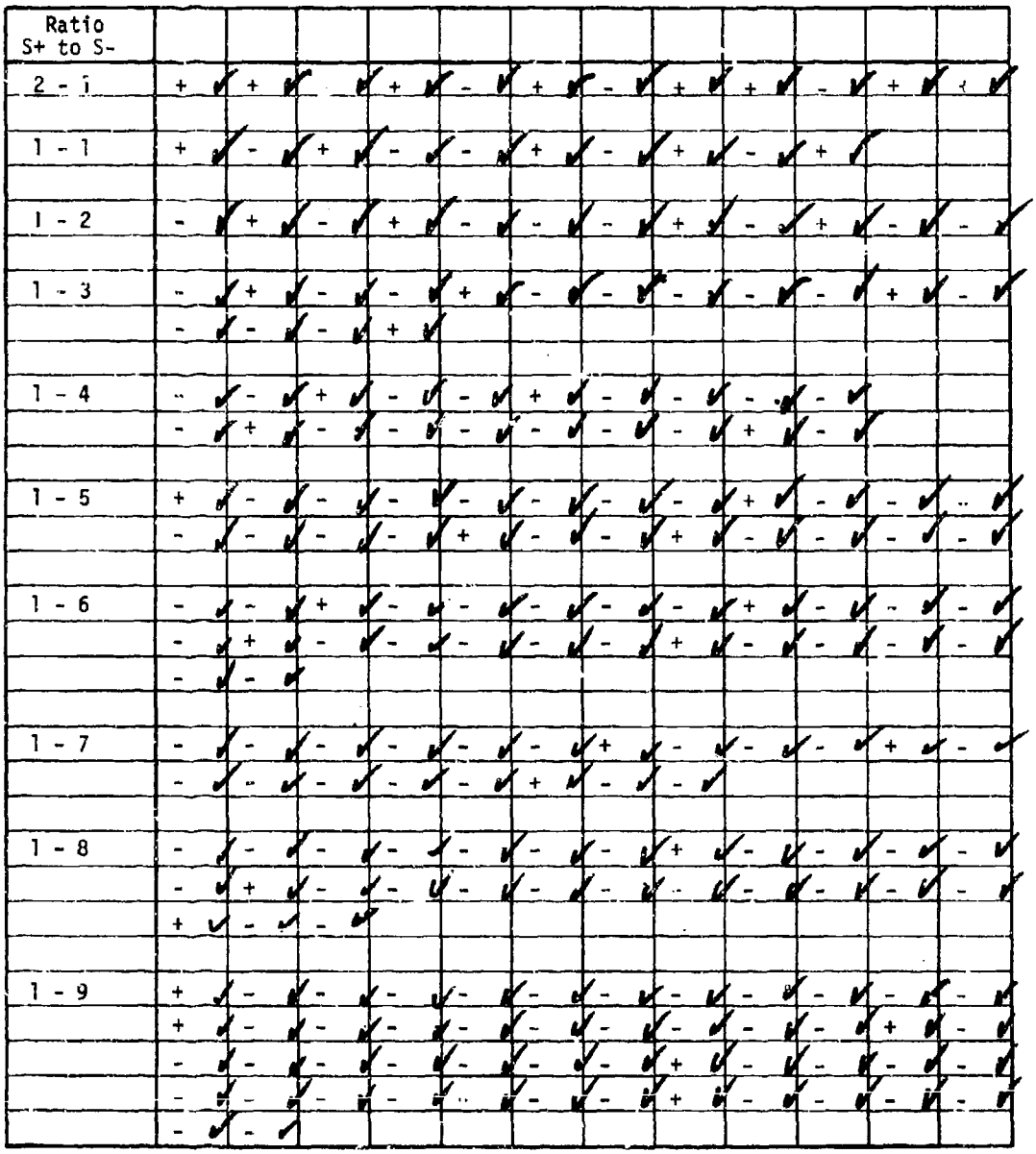


Figure 7. A Filled-Out Scent Association Data Sheet.

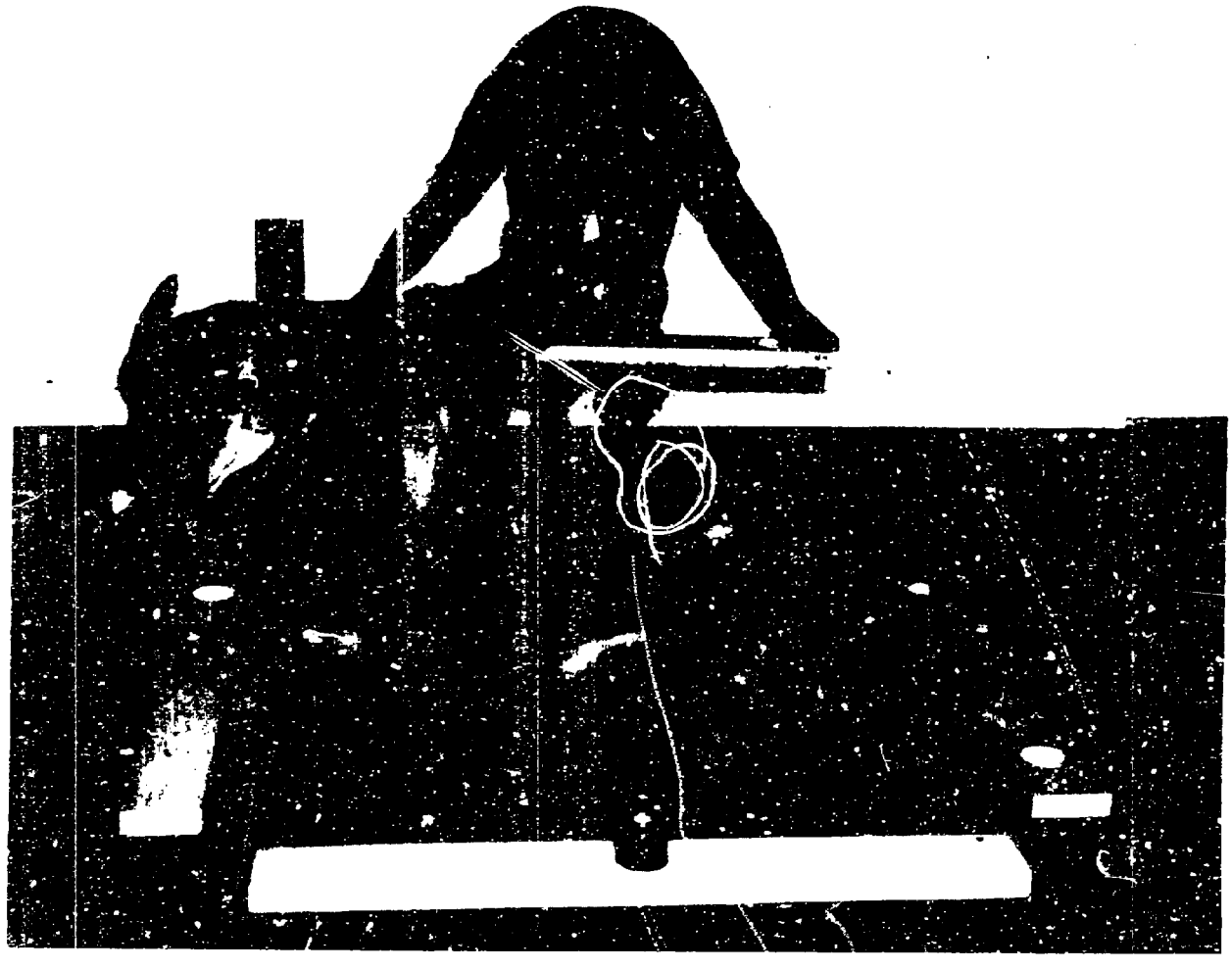


Figure 8. Phase II Scent Association. Dog is Led to an S+ or S- Jar on a Scent Association Board.

stimulus should be presented to the dog and the dog should be rewarded. A minus (-) in a column means that an S- stimulus should be presented and the dog should not be rewarded. As each trial is completed, it should be checked off in the box below the + or - designations. In this way, one can be sure that the training is completed according to schedule. A completed data sheet is shown in Figure 5. As can be seen by the check marks, forty trials have been run. The dog has received 19 S+ trials for which it received food and praise and 21 S- trials for which there was no reward. The schedule given here can be used in both Phase I and Phase II.

Contamination

There are several problems in training a dog to detect odorous materials, one of which is "contamination," e.g., any displacement of an S+ odor to a place or object that is not intended to be an S+. The various S+ odors must be kept isolated from each other, and no S+ odor should come into contact with any material to which the dog may subsequently be exposed. Extreme care is essential in controlling for contamination since dogs are capable of detecting incredibly small concentrations of many odors. One rule to follow in controlling contamination is to always handle the S+ odor last and assume that anything you touch after you have handled the S+ material is contaminated. A workable solution to handling the S+ and S- jars is to have the programmer always move only the S+ jars with his left hand. If a S- jar is moved with the wrong hand the scent could be transferred from the S+ to S- jar (Figure 9).

A dog's keen ability to detect odors is an obvious advantage in detection training; however, problems such as contamination will arise if extreme care is not taken when working with the various odors to be detected. The problem of contamination is fairly easy to handle in this first phase of training; however, proper control becomes more difficult in later training.

Before olfactory training begins, secure a separate place to store each S+ material. This must be a place to which the dog will never be exposed. Any person who handles an S+ material should confine himself to the area designated for that particular S+ until he has thoroughly washed his hands. All materials which are put into the designated area are then considered contaminated and should be kept in the area, thoroughly cleaned, or destroyed.

During this initial training, one S+ odor will be employed. Later, in working with several S+ odors, a separate place to store each of the S+ materials will be needed.

IN PREPARING THE S+ AND S- STIMULI, THE S- MUST BE HANDLED BEFORE THE S+ STIMULI AND NEVER IN THE REVERSE ORDER. This is a basic rule and must be observed during all phases of training. Failure to follow this rule is the most frequent cause of contamination. During this initial training phase it is relatively easy to secure a separate place to store each S+ material and thus help control the problem of contamination. The simplest way to go about preparing the S+ and S- stimuli to be used in Phase I is to attach six identical jars each to a wooden board and then load two of the jars with dynamite. The same individual should make up both the S+ and S- stimuli; otherwise, there will be different human odors associated with the S+ and S- stimuli (Figure 10).

Figure 9. Trainer Carrying S+ Jar in His Left Hand as Per Proper Procedure.

Figure 10. Shelf Assembly Used for Holding and Storage of S+ Jars.

DISCRIMINATION TRAINING

Scent Discrimination

Once Phases I and II of initial olfactory training have been completed, four-choice discrimination training should begin. Discrimination training means training in which the dog will be required to make a distinction between the S+ and S- stimuli. During this phase the dog will learn to sniff the jars and to sit when it sniffs the S+ jar. To insure control of the dog's movements, this phase of training should be conducted with the dog on-leash. This training can be conducted either inside or outside a building, provided there are no strong wind currents. The materials used in this training will be three S- jars and one S+ jar, identical to those used in initial olfactory training. These jars are placed in four positions: north, east, south, and west (Figure 11).

There are approximately four feet between the jars in the N and in the S positions, and a like distance between the jars in the E and W positions. The positions of the S+ and S- stimuli are changed on each trial. Thus, if the S+ is in the N position on one trial, it will be changed to another position on the subsequent trial. This training should be continued until the dog reliably sits after it sniffs the S+ jar and does not make a sit response to the S- jars.

In the initial discrimination training trials the dog will only be required to sniff the S+ jar to get the reward. Timing is very important here. At the instant the dog sniffs the S+ jar, the handler immediately says GOOD DOG and gives the dog the food reward. The training should begin with only the S+ jar for a few trials. As soon as the dog has learned to sniff the S+ jar, one S- jar should be added. Then, after the dog has received several trials with the two stimuli, add the third and fourth jars.

After the dog has been run through several trials in the four-choice discrimination task, it will begin to alert after it sniffs the S+ jar. Once this alerting behavior is noticeable, the sit response to the S+ stimuli should be added.

When the dog sniffs the S+ jar, the handler says GOOD DOG and pushes down gently on the dog's croup with his left hand. Simultaneously, he takes a piece of food in his closed right hand, holds it over the dog's nose and raises his hand. This combination of pressure on the croup and the nose following the food should cause the dog to sit automatically (Figure 12).

As the dog is pressed into the sitting position, the command SIT should be continually repeated. After a few trials, the physical and verbal cues should gradually be reduced until the dog is sitting to the S+ without being prompted by the handler in any way.

Search Command

It is desirable to have the dog search on command. Upon entering the area to be searched, the dog should be given the command SEARCH.

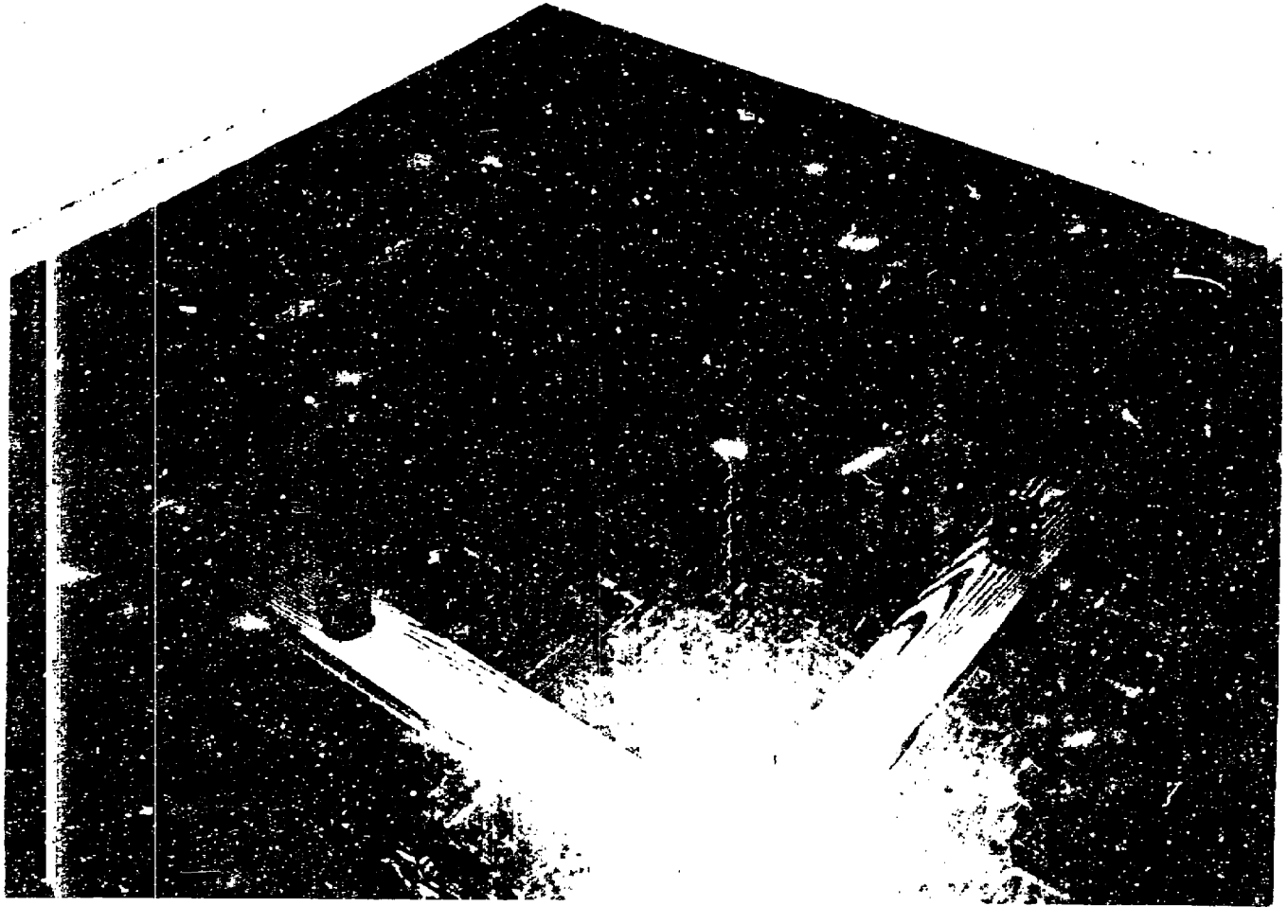


Figure 11. Physical Layout for Four-Choice Discrimination Training.

Figure 12. Trainer Teaching Dog to Sit After Smelling S+ Jar.

There will be times when the dog will be required to search some particular area or object within the general area being searched. In these instances the handler should move to the area or object, get the dog's attention, indicate the object by moving his finger to the object, and give the search command.

To insure the dog's prompt response to the search command, careful training will have to be given. This training should begin as early as possible, preferably during the first stages of the four-choice discrimination task. The dog must learn that when an area or object is indicated and the search command is given, it is more likely to detect an S+ odor than if it ignores the command. In order to establish and maintain this "search-find-reward" association, systematic conditioning of this association throughout training is necessary.

Establishing the association between the verbal command SEARCH and the increased likelihood of finding an S+ during the initial trials of the four-choice discrimination task will facilitate more rapid learning of the discrimination task, and in addition, will establish the search command as a signal for the dog to search more vigorously.

In order for the dog to learn to search more vigorously when the search command is given, the handler will have to give the dog the command just prior to making a detection. Begin by giving the command prior to the detection of the S+ on every trial. After several trials in which the search command is given on every trial, the command is then given on progressively fewer trials. The ratio of reinforcements to trials followed in initial olfactory training (see Basic Odor Discrimination) is a good schedule to follow in programming the trials on which the dog receives the search command.

If the search command were given just before the dog sniffs the S+ and at no other time, the dog will soon learn that it will be rewarded any time it hears the search command and sits. To insure that this behavior does not develop, the search command should be given just before the dog sniffs the S- stimuli on some trials. The percentage of times it is given to S- should be increased gradually.

The systematic presentation of the command SEARCH outlined above will result in the dog learning to search when the search command is given; but the dog will continue to rely on the sense of smell in making the distinction between the S+ and S-.

Touch -- Do Not Disturb

After the dog has learned that the S+ odor means reward, it may, if not corrected, develop a potentially bad habit. Occasionally a dog will paw the S+ jar or may even take it into its mouth. Needless to say such behavior would be undesirable when the dog is searching for explosives. Therefore, do not allow this habit of pawing, biting or otherwise disturbing the target to develop. Of course, it would be even better for the dog not to touch the S+ object at all. Practically speaking, however, such a prohibition may slow down the training and may also reduce the dog's detection capabilities.

In order to keep this habit of pawing or mouthing the object from developing, do not reward the dog if it engages in these behaviors. This problem does not generally arise if reward follows the sit response very quickly. However, if there is a delay between the time the dog sits and the time it is rewarded, such behavior may occur. If the dog displays the behavior and is subsequently rewarded, it is likely to respond in the same way on the next trial. Therefore, if the dog paws or otherwise disturbs the S+ stimuli, it is relatively easy to keep such a habit as this from developing; but once it has developed, it may be extremely difficult to break. If the dog engages in these behaviors before it sits, the verbal command NO is given followed by the command SIT. If the dog responds to these commands, that is, if it stops disturbing the S+ and sits, it should be given a food reward. If it does not stop engaging in these behaviors when the command NO is given, the NO command should be repeated and the dog removed from the area. The dog may touch the object with its nose, but it is not to disturb it. It must be remembered, however, that any contact of the object by the dog will "mark" that object, i.e., identify it. Once marked by a dog, an object cannot be used for further discrimination training until it is thoroughly cleaned.

Discrimination Training (Six-Choice)

Once a dog has learned the four-choice discrimination task (100 percent correct responses for at least one entire session), the next step in training is the standard six-choice discrimination task.

The apparatus is shown in Figure 13. It should be set up in an enclosed area where there are no noticeable wind currents.

Two trainers are necessary to conduct six-choice discrimination sessions, a programmer and a handler. The programmer will change the S+ and S- stimuli and keep the data. The handler will handle the dog and administer rewards for correct responses (Figure 14).

There are six phases of training which should be completed with dynamite in the six-choice discrimination task before any attempt is made to work with additional explosive odors. The dog is run on-leash in the first four steps of training and off-leash during the last two steps. The six phases are as follows:

(1) Acclimatization

(2) S- odors added to empty jars

(3) Delay in reward training

(a) Primary (food)

(b) Secondary (praise)

(c) Primary and secondary (food and praise)

(4) Handler's knowledge of the position of the S+ eliminated

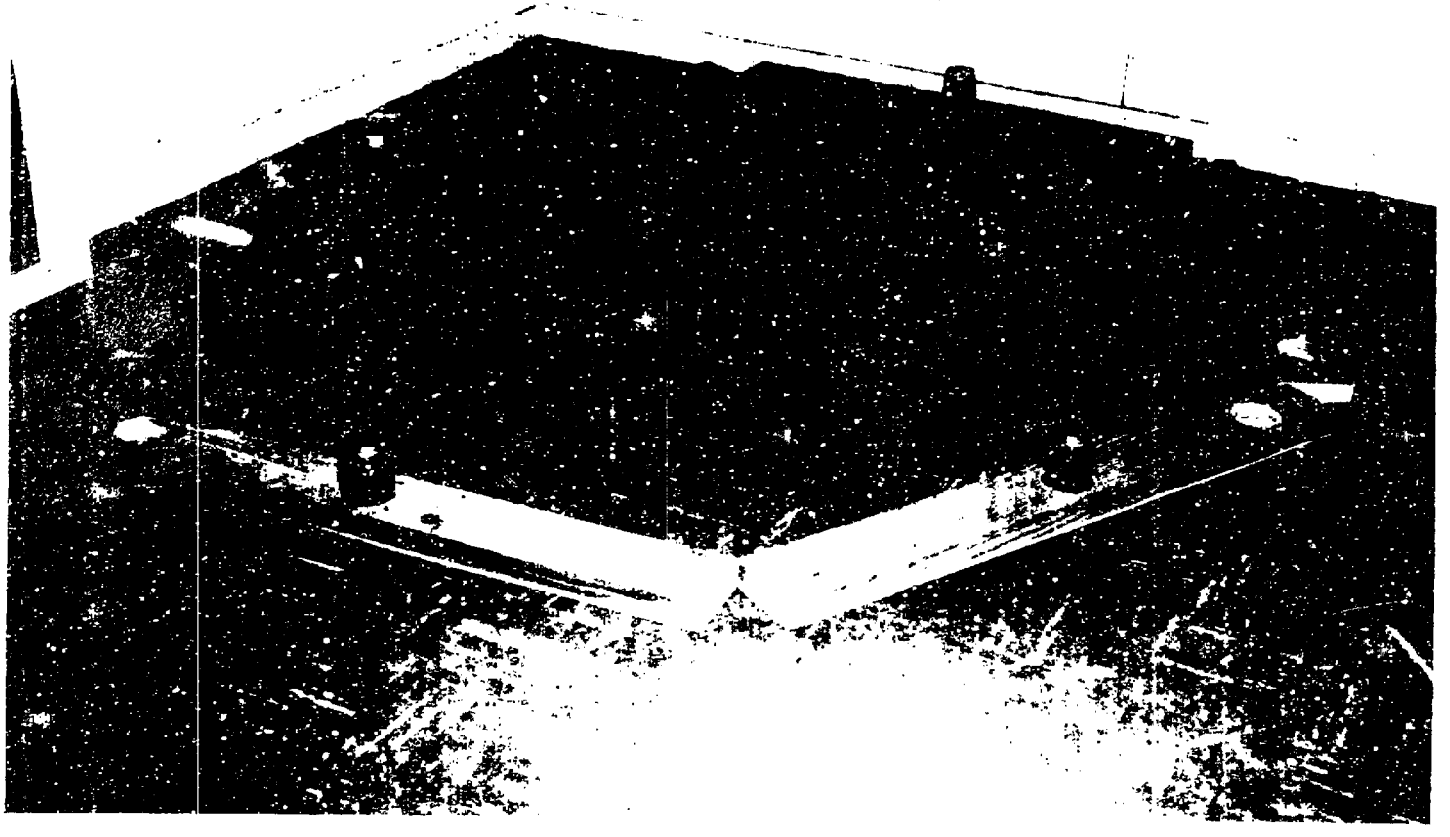


Figure 16. Physical Layout for Six-Choice Discrimination Training.

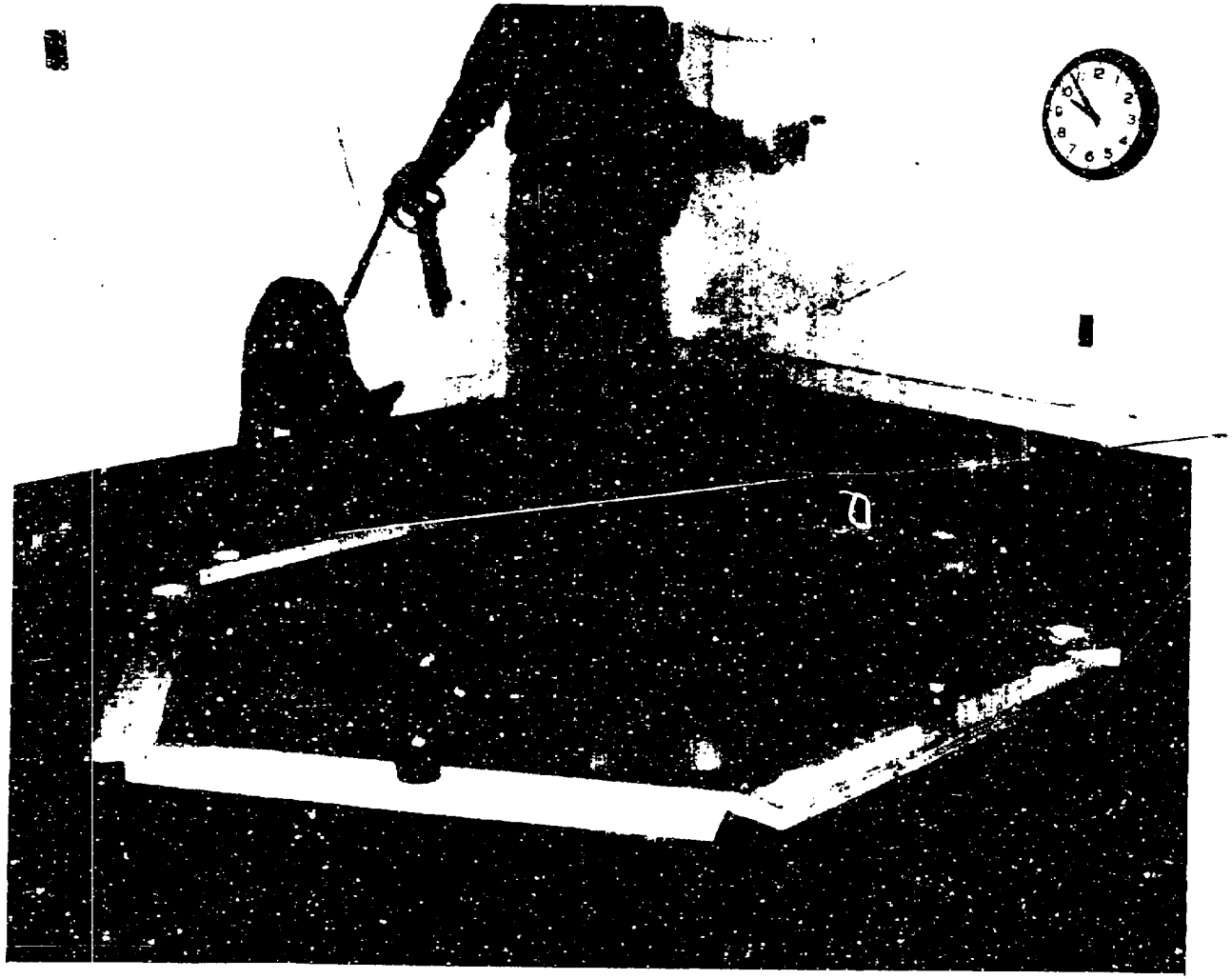


Figure 14. Handler Working Dog Through a Six-Choice Discrimination Training Exercise.

(5) Off-leash training

(6) Sensitivity training

These steps should be taken one at a time and performance should approximate 100 percent at each step before the next step is taken.

Steps of Discrimination

Step 1. Acclimatization - Acclimatization bridges the gap from simple, four-choice discrimination to the new apparatus and procedure. Two adjoining rooms should be used. One room will house the apparatus and the second room is where the dog is kept between trials.

(1) The handler will bring the dog into the room, give the search command and then lead the dog to the six jars. The programmer will tell the handler which position the S+ occupies on each trial. This is done so that reward or correction can be given immediately after the responses.

(2) If the dog comes into the room, sniffs the jars, does not sit to the S- jars, and sits to the S+ jar, it has given a correct response and should receive food, petting, and praise and then should be taken from the room to await the next trial.

(3) If the dog sits to one of the S- stimuli, it has given an incorrect response and terminates the trial. If the dog sniffs one of the S- stimuli and starts to sit, the handler should say "NO!" and immediately remove the dog from the room. There should be no food or praise given until the dog makes a correct response on a subsequent trial. The above error is referred to as a FALSE SIT.

(4) Another type error is a failure to sit when the S+ stimuli has sampled. There is no correction for this error. The dog is simply redi to all stimuli.

(5) If either of these errors persist, revert to an easier task. I case, if the dog continues to make errors, revert to the procedure used establish the sit response to the S+ jar in the four-choice situation, ex continue to use the six-choice discrimination apparatus.

(6) The programmer will move the S+ and S- stimuli to new positions on each trial. He will tell the handler the new position of the S+ on each trial and keep the data sheets. A sample data sheet for recording the data in the six-choice discrimination is presented in the following section.

(7) In addition to helping the dog become familiar with the new apparatus, this initial training step will allow both the handler and programmer to become familiar with the procedure and the data collecting.

Step 2. Introduction of S- Odors - Once the dog can discriminate the S+ from the five empty jars, other odorous materials should be put into the empty jars. The purpose here is to insure that the dog is not simply responding to

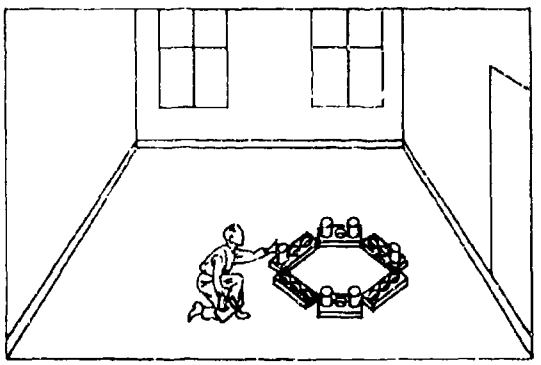
"something versus nothing" but that it is discriminating the odor of the S+ from other odors. Any foreign odor can be used as an S- odor, and the more different S- odors introduced into training the better. Any material which has been or will be systematically associated with S+ stimuli must be included. For example, any packaging material used with the S+ odor should be included as S- material. The operational procedure is the same as in Step 1. A record should be kept of any S- odors to which false sits are made.

Step 3. Delay of Reward Training - Up to this point the person who handled the dog has known the position of the S+ prior to the dog's response. Knowledge of which jar contained the S+ odor insured reinforcement, as later in training there will necessarily be times when immediate reinforcement is not feasible. Unless the dog has had some exposure to such delays in reinforcement, an unexpected delay could disrupt the dog's behavior. There are three phases in this training step. Phase A introduces a delay between the time the handler says GOOD DOG and the time he gives food. Phase B introduces a delay between the time when the dog sits and the time the handler says GOOD DOG. Phase C is a combination of both of these delays on a single trial. Although the length of delay in reinforcement may be extended later in training, a moderate delay (up to 5 seconds) should be sufficient at this stage of training. Each delay should be built up gradually, beginning with no delay.

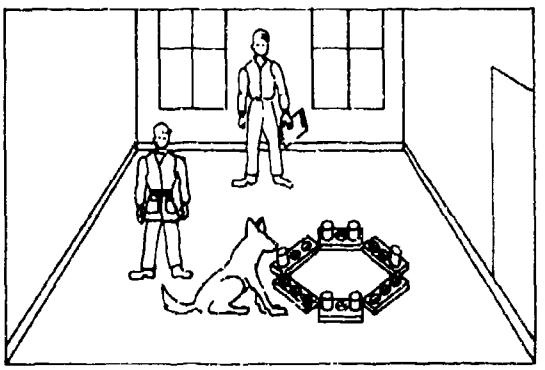
Step 4. Elimination of the Handler's Knowledge of Position of S+ - Under most training conditions the handler should not know the position of the S+ stimuli. A handler who knows where the S+ is cannot avoid giving cues to the dog, even though he may be unaware of doing it. It can be assumed that if he does not know where the S+ is located, he cannot cue the dog to the S+. Therefore, during this training step the handler will no longer know the position of the S+ until after the dog has made a response. The dog is brought into the room and is guided to the jars in the same manner as in prior steps. When the dog responds, the programmer will quietly say YES to the handler if the dog has responded correctly and NO if the dog has responded incorrectly. The handler will then reward the dog for correct responses in the usual manner (Figure 15).

Step 5. Off-Leash Training - The dog should be trained to work on-leash and off-leash. Once the dog is working well on-leash with a handler who does not know the position of the S+ samples in the six-choice discrimination task, a series of trials with the dog off-leash should be run. If the dog has been working well on-leash there should be no difficulty in working it off-leash. The dog's search pattern can be directed by pointing to a particular object and by verbally encouraging it to search. The handler should not know the position of the S+ until after the dog has responded during off-leash training.

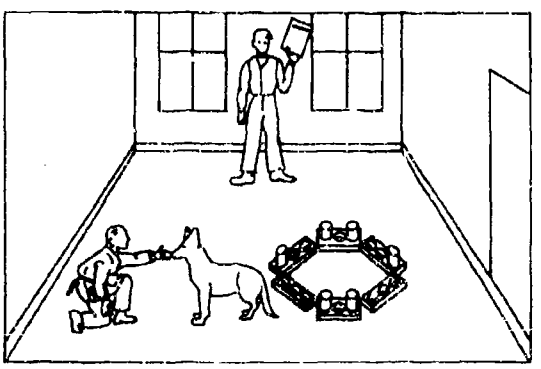
Step 6. Sensitivity Training - Dynamite has an intense odor and can be detected very easily. In order for the dog to detect the weaker explosive odors, it will need to sniff in the most effective way and to attend to very faint odors. This is why the dog should be trained to respond to low concentrations of the training odor in the six-choice discrimination task before working with the new explosive odors. When the dog has mastered the discrimination task with a 3/8 inch hole in the top of the S+ jar, the hole should be made smaller and smaller. The recommended sequence is 1/4, 3/16, 1/8, 3/32, 1/16 inches and a No. 60 drill size. Once the dog has learned to detect even the faintest amount of an S+, there is less chance that difficulties will



(a) Between Trials. Programmer (With Clipboard) Changes Position of S+ Jar.



(b) After Searching Room, Dog Sits at S+ Jar. Handler (With Apron) Does Not Know Correct S+ Location.



(c) Programmer Signals Correct Response. Handler Rewards Dog.

Figure 15

arise in training it to search for the stronger S+. WARNING: Care and close supervision of all personnel handling explosives must be exercised to prevent accidents.

False Sits

There will be occasions when the dog will sit where there is no S+ present. In the four-choice situations there are three S- jars and one S+ jar. This is an error which is referred to in this report as a false sit.

The question is: What to do if the dog sits to one of the S- stimuli? While there are various possible ways to deal with this type of error, the best overall is to give the conditioned negative reinforcer NO and remove the dog from the vicinity of the S+ or S- stimuli. For example, if, during discrimination training in the two, three, or four-choice discrimination task, the dog approaches, sniffs the S- and sits, the handler should say NO in a normal tor and take the dog back to the starting position. He should not pet or otherwise praise the dog until it has made a correct response. In most cases this correction procedure will suffice to eliminate false sits. If the dog continues to make false sits in this situation, it is most likely that it has not made the association between the odor and the sit response. If the association between the odor and the sit response apparently has not been made, revert to giving praise and food without requiring the dog to sit. That is, when the dog starts to make systematic or frequent errors, return to a more elementary stage of training and work back up to the point where the desired behavior has become chronic before backing up. Always back up enough to insure that the dog will respond successfully; then, after a number of correct responses at the more elementary level, continue to re-move gradually toward the desired goal.

Transition From Easy to Difficult Odors

After the dog has progressed through the six training stages just described, it is ready to begin discrimination training for various other explosive odors. Prior to the beginning of training to any explosive odors, it is best to determine all of the kinds of explosives the dog will be expected to detect. Explosive compounds vary tremendously in the amount of odor they produce. That is, some explosives, such as dynamite and C-3, have intense odors, whereas others, such as TNT, give off very little odor and are, in fact, considered odorless to humans. Although the correlation between human and canine olfactory sensitivity to various substances has not been investigated, it may be assumed that, in general, what has a strong odor to humans also has a very strong odor to dogs; and a material which has a weak or nonexistent odor to humans is unlikely to have a strong odor for dogs. For the purpose of this report the following explosives will be considered:

a. Commercial ammonium nitrate dynamite

b. Commercial straight nitroglycerin dynamite

c. C-3

d. C-4

e. Smokeless powder

f. Black powder

g. TNT

The first four explosives included in this list (two types of dynamite, C-3 and C-4) all are odorous to humans and are easily detected by dogs (Figure 16).

Smokeless powders of various compositions all contain nitrocellulose; double base powders also contain nitroglycerin and both single and double base smokeless powders may vary greatly in odor intensity. Black powder and TNT are generally odorless to humans and are relatively difficult for dogs to detect.

In training a dog to detect any combination of these explosives, the training should be given in the same sequence as the explosives are listed. That is, train the dog first to detect both types of dynamite, then C-3 and C-4 and so on down the list. It is not necessary to train the dog to detect all the explosives in the list, nor to confine the training to the explosives listed here. Regardless of which explosives are used, the training should be given with the least odorous explosives last.

Transfer To Other Explosive Odors

After completing the six steps outlined previously, the dog should be ready for training to other explosive odors. The procedure presented here for training the dog to respond to an additional S+ is relatively simple and has been found to be very fast and effective. The same six-choice discrimination procedure previously used with dynamite will be used to train the dog to new odors. The technique for transferring to the new S+ odor, which in this case is C-3, is as follows:

a. Begin the session with a few trials using the dynamite. This will assure that the dog will work on the six-choice discrimination task.

b. Once the dog is working well, remove the jar containing the dynamite and put the new S+ jar, which contains a generous quantity of C-3, in its place.

c. On the first trial with the new S+, the dog is brought in and will begin to sniff each of the jars, just as it has previously done. At the precise instant the dog sniffs the new S+ jar, the handler should immediately say GOOD DOG and feed the dog. Initially the programmer will tell the handler the position of the S+ (C-3) prior to the beginning of the trial. As the dog is fed it should be gently placed in the sitting position in the same manner as in the early training. Continue in this manner until the dog starts to alert when it sniffs the S+. At this time gradually demand more and more from the dog. Give it time to sit without being coaxed or physically assisted. Once the dog begins to sit on its own, delay saying GOOD DOG for a second or two, thus giving the dog a chance to sit before reinforcement is given.

The rate at which the dog learns to respond to the new S+ odor depends largely on how well the handler times his responses. If his timing is poor, the dog

1. COMMERCIAL AMMONIUM NITRATE DYNAMITE

2. COMMERCIAL STRAIGHT NITROGLYCERINE DYNAMITE

3. C-3

4. C-4

5. SMOKELESS POWDER

6. BLACK POWDER

7. TNT

Figure 16. Common Explosives Ranged In Order From Most to Least Odorous

will take a much longer time to lear to respond to the new odor. The most essential aspect of this transfer procedure is that the verbal cue (GOOD DOG) COMES AT THE EXACT TIME THE DOG SNIFFS THE NEW S+ JAR. If the timing is good, it will take only a few trials for the dog to begin to associate the new odor with food and praise. Once the dog has learned this association, progress through all the steps in Six-Choice Discrimination Training with the new odor. This should not take as long as it did with the dynamite training.

As with all other procedures in this report, go back to a task the dog has previously learned any time the behavior of the dog becomes disrupted. Reinstate the desired behavior and then gradually move to the new task. If the dog begins to make errors or quits sniffing the jars during the initial trials with the new S+, go back to using the dynamite until a reliable response is reestablished; then reinstate the new S+ on some of the trials.

If it appears that the dog is still having difficulty in discrimination of the new odor, another method of transferring to the S+ may be required. This method is called the "Mixing Method."

a. Begin by removing half of the dynamite S+(a) and replacing it with a like amount of C-3(b). By scent association the dog learns that he will be rewarded for sitting at scent a+b (dynamite and C-3).

b. By reducing the amount of dynamite and increasing the amount of C-3, the dog's previously learned response is transferred from the old S+ to the new S+ (Figure 17).

c. A full transfer to new S+ is recognized when the dog will alert to either S+ (a or b).

Performance Records

It is essential to keep records of the dog's daily performance during discrimination training for use in planning the next day's training session. If several dogs are being trained, it is difficult to recall the details of each dog's performance. Every dog will have individual strong and weak points at any time, and these must be considered in planning its work schedule.

Graphing the daily percentage of detections throughout training is not necessary. Such graphs actually contain very little meaningful information. The recorded level of performance depends largely upon the intensity of the odors that are being used, but the selection of the odor intensities to use at any time depends upon the trainer's judgments as to the dog's current performance. The principle use of the daily records is thus to aid in planning the next day's training, not to evaluate the progress of the dog which can vary greatly. They also indicate any tendency of the programmer to place the S+ in certain locations too frequently or to favor certain changes in location from one trial to the next. If desired, the locations can be listed in advance to assure that the locations are at least semi-random.

A sample data sheet used in six-choice discrimination training is shown in Figure 18.

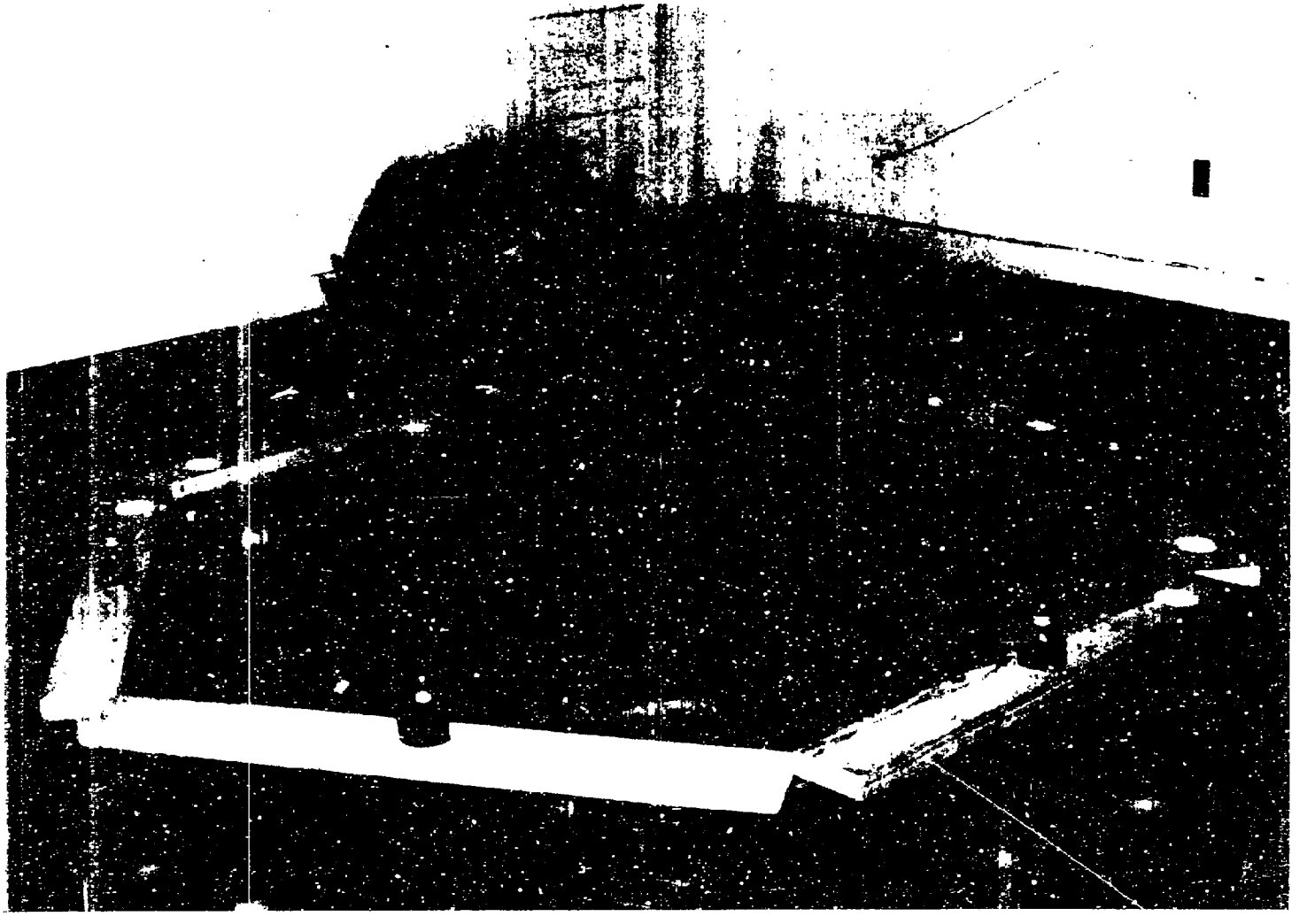


Figure 17. Dog Responding to the Presence of a New S+ Scent.

SIX-CHOICE SCENT DISCRIMINATION DATA SHEET

PROGRAMMER: WILLIAMS TRAINER: LOMAX

DOG's NAME: KIT DATE: MAY 29, 1973

TRIAL NO.	Location S+			S-	S-	S-	S-	S-				
1	4	-		+1								
2	7	0		-	+4							
3	9	+		-	-	-	-	-				
4	6	+		-	-	-	-	-				
5	1	-		-	-	-	*	*	Poor search behavior (cued) continued poor search. Removed from room.			
6	9	+		-	-	-	-					
7	12	+		-	-							
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20												
NOTES:	HOLE	SIZE:	1/16	INCH								

Figure 18. A Sample Six-Choice Scent Discrimination Data Sheet.

The symbols used in keeping these data sheets are: S+, S-, +, -, and O. The number in the location column represents the location of the S+ stimulus in the room (Figure 19).

Response to the S+ odor is recorded in the column labeled S+. A plus (+) in this column means that the dog sniffed the S+ odor and sat down beside it. A minus (-) in the S+ column means that the dog sniffed the S+ odor but did not sit and moved on. A zero (0) in the S+ column means that the dog did not approach the S+ odor at all. The five columns labeled S- are the spaces to record responses to S-. The correct response, i.e., sniffing the S- odor jar and moving on, would be recorded by placing a minus in the S- column. The location of S- odor jars need not be recorded unless the dog sits to an S- jar. When this occurs, the trial terminates and a plus is recorded in the S- column along with the position number of the hole where the S- jar is located. An asterisk (*) in the S- column is used to indicate that the dog was cued by the handler for some reason. An explanation such as the one on the sample data sheet (Trial 5) should be indicated.

Trial 7 shows a plus in the S+ column and two minuses under the S- group. This indicates that the dog attended two S- jars before going to the S+ odor. The correct response to an S+ odor terminated Trial 7 at that point. The record for Trial 1 on the data sheet shows that the dog sniffed the S+ odor and moved on without sitting. It then sniffed an S- jar and sat down. An incorrect response to an S- ends the trial. The data recorded for Trial 2 show that the dog did not approach two S- jars and sat to the second S- jar, thus ending the trial. In Trials 3 and 4 the dog approached all five of the S- jars and then came to the S+ jar to which it responded correctly.

Transition From Discrimination Training

As the dog successfully progresses through discrimination training, thought must be given to transferring to room search techniques. At this stage of training the dog should be moving from jar to jar, off-leash. A pattern is developed by the handler always stopping at the door and starting his dog moving around the room, left to right, at the command SEARCH (Figure 20).

The room at this time is empty, except for the training jars. With the search pattern established, move one chair into the room. Always continue to leave the S- and S+ jars in full view.

After the dog has successfully completed several runs with a chair in the room, move one of the jars beside the chair leg. Later, place one jar behind the front leg and later near the rear of the chair. Continue to relocate the S+ jar, sometimes near or behind the chair and sometimes in plain view. Additional methods will be discussed in "Room Search."

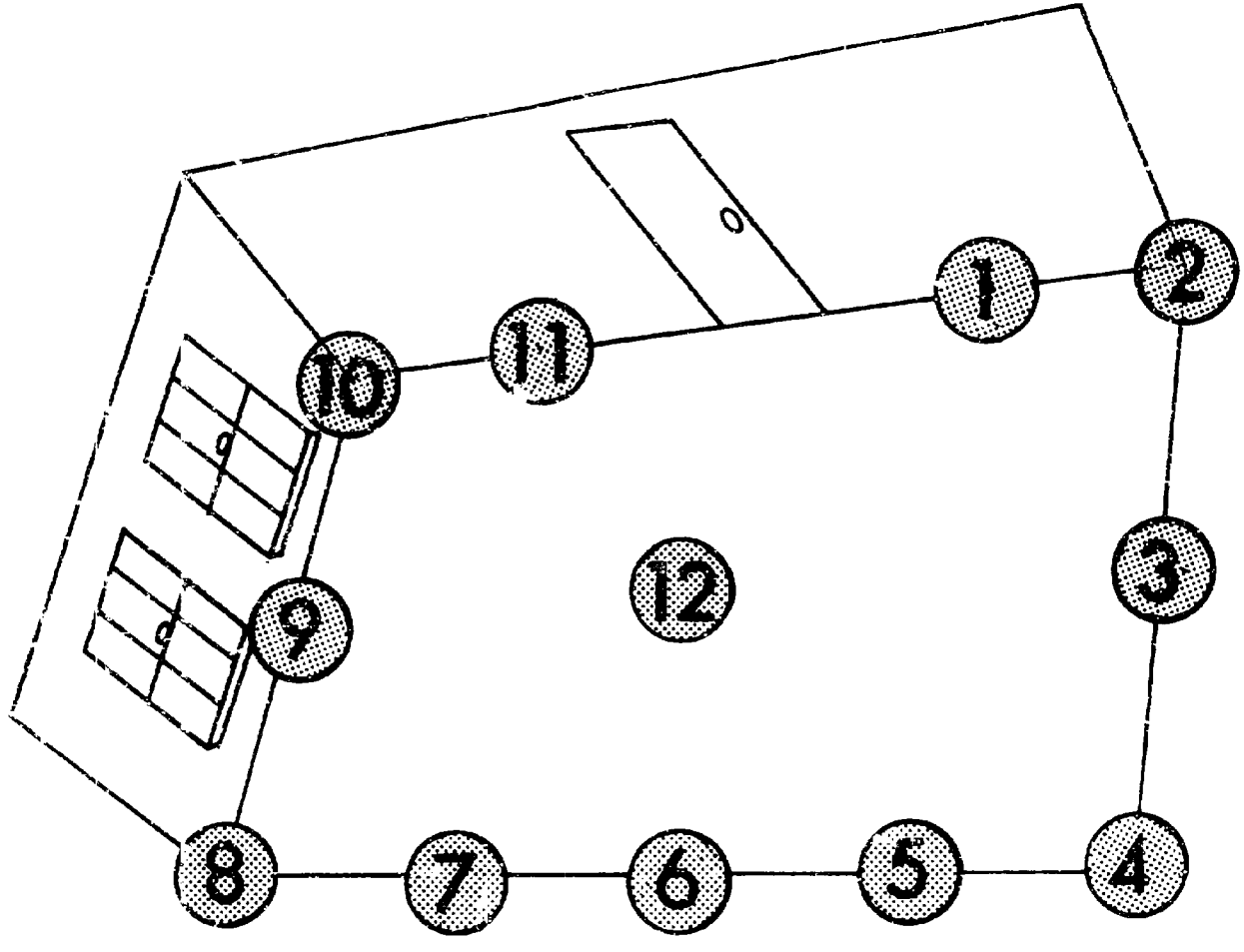


Figure 19. Locations for S+ and S- Jars in Training Room. These Numbers are Recorded on the Six-Choice Scent Discrimination Data Sheet.

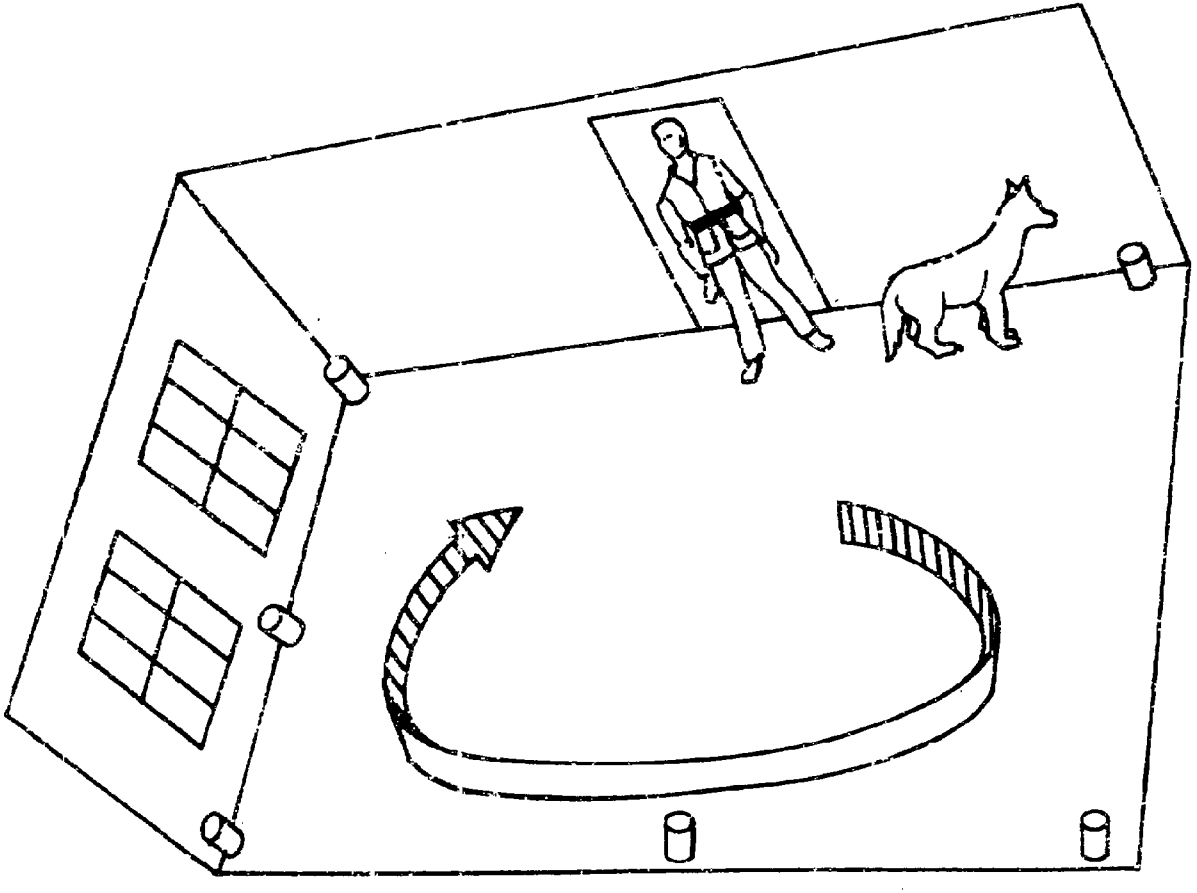


Figure 20. Early Room Search Training. Room is Bare Except for Training Jars. Search Pattern is Always Counterclockwise, From Left to Right.

ROOM SEARCH

Introduction

To have practical value, a dog must not only learn to discriminate S+ odors, but also learn to search an area actively and to locate an explosive material if one is present. After the dog has learned to discriminate dynamite and C-4 in the six-choice situation, room-search training should begin.

During room search training the handler should never know the location of any S+ samples. Consequently, it will always take at least two people to run room search trials. If the handler knows where the S+ has been planted, he will almost certainly unconsciously cue the dog, even though he is deliberately trying not to. Therefore, it is essential that the handler not know the position of the S+ during room search training. There will be times when the dog should be directed during room search training. The handler can direct the dog to search a certain specific area or a particular object if he thinks the area may contain likely hiding places, but he runs a great risk of unconsciously cueing the dog if the location of the S+ stimuli is actually known. After the dog sits, the programmer will give the signal YES (correct) or NO (incorrect) and the handler will reinforce the dog accordingly.

Basic Room Search

Begin training in a small, empty room (Figure 21). On the first trial one S+ jar and two S- jars should be placed where the dog will be sure to see them. These initial trials may be run with the dog on- or off-leash. The reinforcement contingencies are the same in room-search training as in the six-choice situation--immediate reinforcement when the dog sits. Give food and praise if the response is correct or NO and removal from the room if the response is incorrect. The programmer will know which jar contains the S+ on these trials and will signal the handler immediately following the dog's response. The location of the S+ and S- samples should be moved by the programmer on each trial. Once the dog is responding reliably to the easily located S+ jars, make the task more difficult by planting the S+ jars in less obvious places in the room. Do this gradually so the dog will have to work just a little harder on each trial. After the dog has learned that it has to move around the room and sample several S- jars, arrange the jars so that only a small part of each jar is visible. For example, the jars may be placed in open boxes which are scattered around the room (Figure 22).

Continue to reduce the visual cue until the jar is completely out of sight (Figure 23).

The dog must then rely completely on the sense of smell to locate the S- odor. Once this is done, the proportion of the jars that are S- can be reduced to approximately one-fourth.

Problem Situations

In an earlier section it was pointed out that the dog may touch but may not disturb S+ samples. There is a possibility that as visual cues are removed,

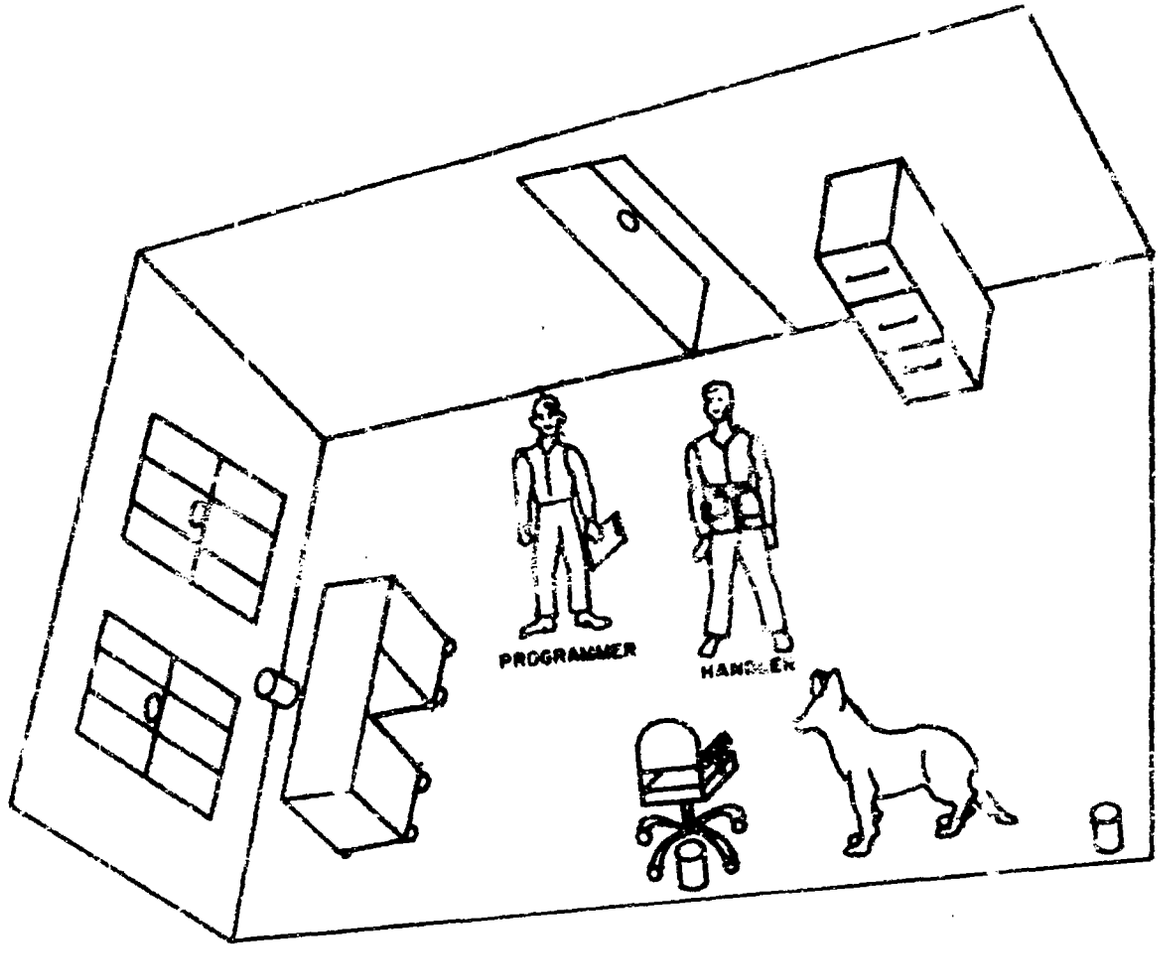


Figure 21. Basic Room Search Training. Training Jars are Easily Visible.

Figure 22. Dog Sniffing S+ Jar Hidden in Open Box.

Figure 23. Dog Searching for St Jar Completely Hidden in Box.

the dog will try to find the S+ jar by nosing the place where it is hidden or by pawing the object that conceals the jar. Here again the rule is not to let these habits develop. If the dog sits and then begins to display such behaviors, the handler should say NO and give the command SIT.

After the dog has learned to sample a limited area with the S+ hidden from sight, training should move to a larger area which contains more objects. As with all phases of training, always program in small steps and be sure the dog has learned one task well before taking the next step. If the progression to a more difficult task indicates that the dog is not performing well, go back to a task in which the dog has done well and then gradually move toward the more difficult task.

Once the dog is responding well in a room containing several objects, additional rooms should be incorporated into the dog's search pattern. During the initial room search training, there should always be at least one S+ in every room. The number of rooms to be searched should be increased gradually. Once the dog is performing well in the multi-room situation, there should be introduced some S- rooms, that is, rooms in which there has been no S+ planted. The handler should not be told in advance whether a room he is about to search is an S+ room or an S- room.

It is not essential that the dog detect every S+ which has been planted. However, as fewer rooms come to have an S+ planted in them, and as larger rooms are used, care must be taken not to require the dog to search too many and too large rooms without detecting an S+. If area searched per detection increases too rapidly, the search behavior may deteriorate. So, progress slowly in increasing room size or decreasing the number of S+ rooms; the dog should be adapted gradually to searching larger and larger areas in which there are fewer and fewer S+ stimuli present.

Recording of Performance

The data sheet in Figure 24 represents a record of the performance which might be expected from a dog with limited multi-room search training in the detection of dynamite and C-4. The analysis of the data sheet is also presented to illustrate some of the conditions which will likely be experienced during this stage of training. In addition, the analysis illustrates an efficient method of keeping a record of the dog's performance.

The data sheet for room search should have spaces to record the trial number, room number, whether the room contains an S+, the type of S+ (if any), and should have columns for recording the dog's performance. The sheet should be labeled with the information regarding the purpose of the training session, the place, the date, the name of the dog and the names of the handler and programmer.

The dog's performance in each room and the time spent in each room should be recorded for each trial. A plus (+) recorded in the column headed Condition (Cond) indicates that the room contains an S+. A minus (-) in the Condition column indicates that there is not an S+ in the room. the room contains an S+, an initial identifying the type S+ should be put beside the + in the Condition column. Thus, +D for Trial 1 indicates that dynamite is planted in

ROOM SEARCH DATA SHEET

PROGRAMMER: WILLIAMS TRAINER: LOMAX

AREA: BUILDING NO. 3 DATE: JULY 16, 1973

Trial	Room	Cond	Dyn (NG)	Dyn (AN)	C-4	S-		Time/sec	.
1	9	+D	+					17	
2	8							27	
3	7	+D		+				15	
4	6	+D		-				25	
5	Toi	-				+		45	
6	5	+C-4				+		15	
7	4	-				*+		25	*Handler cued the dog to sit
8	3	+D	+					27	
9	2	-						22	
10	1	-						35	
11	10	+D		Q+			*	40	*Dog directed to location of S+ after Handler indicated the room had been thoroughly searched.
12	11	-						31	

Figure 24. A Sample Room Search Data Sheet.

that room. If the dog detects the dynamite and sits, a plus should be recorded in the dynamite column. In Trial 3 the S+ is dynamite, therefore, a +D is recorded. The data for Trial 4 indicate that dynamite was planted in Room 6 but the dog did not detect it. The minus in the dynamite (Dyn) column for Trial 4 shows that the dog approached the dynamite but did not sit. On Trial 5 the dog sat in an S- room. This is recorded by placing a plus in the column headed S-. Trial 6 shows that C-4 was planted in Room 5 and was detected.

As can be seen from the times recorded for other rooms, the dog was kept in Room 5 for a longer period than in any of the other rooms. Although a dog should examine a room carefully, it should not be retained in a room for longer than necessary to complete the room search. If there is an S+ in the room, the dog will likely detect it in a relatively short period of time. As Trial 5 illustrates, if the dog has searched a room and is retained there and made to search the same area repeatedly, the possibility of false sitting is increased. As different dogs are trained, the trainer will become aware of their individual capabilities and will learn the speed at which a particular area can be searched most effectively.

There are two components to good search strategy: (1) percent of detection and (2) speed at which the dog searches an area. Ultimately the dog must search an area as quickly as possible and make a high percentage of detections. If the dog does not sit in an S- room, the programmer plants the S+ materials, prepares the data sheet, directs the handler to the rooms according to the order outlined on the data sheet and records the dog's performance.

NOTE: The schedule gets progressively leaner (fewer S+ rooms) as the session continues.

If at any time during the session the dog is cued, i.e., led to the odor, it should be recorded as such by placing an asterisk and explanatory comment for the trial. The data for Trial 7 show that the dog responded incorrectly but was prompted to do so by the handler. The recording of Trial 11 differs from that of Trial 7, but it is still an example of cueing. On Trial 11 the dog spent 40 seconds in the room without detecting the S+. At that time the handler was told the general location of the S+ and was instructed to direct the dog to that area. The asterisk and explanatory notes were again used to indicate that the dog was cued.

After the entire training session has been completed, a brief summary of the dog's performance should be recorded. Any special problems or unusual behaviors should be included. A brief statement of what would be desirable in the next training session should be made.

Advanced Room Search

Advanced room search is the most lengthy phase of the training program and is also the last phase of training before the dog can be considered ready for operational use. It differs from basic room search only in the degree of difficulty of the task for the dog. As advanced room search progresses, the dog is given practice in searching for S+ samples that are under greater and greater degrees of concealment. An increasing diversity of situations, hiding places, masking odors, packaging, etc., is used so

that by the end of this phase the dog should have been trained to find the explosive samples under conditions approximating almost any it is likely to encounter in actual bomb detections.

Advanced room search is not a discrete phase of training, but a gradual development from basic room search. Once the dog is able to find "easy" samples of a particular S+ in "easy" locations, the samples are gradually made more difficult to find in a variety of ways such as the following:

a. Quantity of S+ material in the jar may be reduced. With the more odorous materials, such as dynamite, the amount may eventually be reduced to a few hundredths of an ounce.

b. The S+ materials may be diluted with larger and larger quantities of S- materials and of as many varieties as convenient. S- jars, containing the same diluents and prepared by the same individuals as the S+ jars, must also be used.

c. The S+ packets, instead of being housed in glass jars, may be wrapped in paper or plastic, may be boxed in pasteboard boxes, or both. The wrapper or box may then be sealed to various degrees with plastic tape (Figure 25). Similar packages, containing packets of various S- materials, should be used along with the S+ packages. If this is done, the same individual(s) who make up the S+ packages should also make the S- packages; the S- ones should always be made first in order to avoid contaminating them with S+ odors. The number of different individuals who prepare the S+ and S- packages, and also the number of different kinds of packaging and sealing materials, should be as large as possible.

d. The time the odor sample has been in place before the room is searched can be lengthened and also made more variable. Times up to 24 hours should be included. As with the other changes mentioned, this change must be introduced gradually. The sharp odor gradient which has characterized the recently planted samples may often dissipate over time making it difficult for the dog to localize the source of an odor.

e. Rooms containing gradually stronger and more varied masking odors should be included. The odors of paint, petroleum products, clothing, people, food, animals, selected chemicals and vegetation are all good masking odors. Where possible, emphasis should be placed on those masking odors that the dog is most likely to encounter in bomb searches.

f. Rooms of increasing size and complexity of shape should be included. The quantity and diversity of the contents should also be increased. These changes should be made very gradually since their effect is to greatly increase the amount of searching required per detection.

g. The samples can be hidden in progressively more difficult locations, especially at increasing elevation above the floor. When this is done, an occasional sample should be hidden in a location of the sort used previously so that the dog will not stop searching the easy areas.

h. If the dog will need to search drafty areas, drafts should be introduced gradually into advanced room search. The handler should be aware that

Figure 25. Dog Detecting S+ Jar in Sealed Box During Advanced Room Search Training.

the draft sometimes causes the dog to sit at considerable distances from the S+ sample.

i. If the dog will need to search for bombs in areas containing people, noisy or moving equipment, or other distractions, a variety of similar distractions should be included in room search (Figure 26).

How gradually this must be done varies with the temperament of the dog. It is well to begin including small distractions early in room searching training, especially if the dog appears to be at all distractable or "skittish."

Training in advanced room search can begin before the transfer to all explosives has been carried out. If convenient, it can start as soon as basic room search training with dynamite and C-4 is finished. If this is done, the dog may receive advanced room search training with strong odors in some sessions, while receiving basic room search training with the next strongest odor in other sessions, six-choice discrimination with the third strongest odor in still other sessions, etc.

Figure 26. Advanced Room Search Training. Dog Being Trained to Ignore Strangers and Loud Talking in the Training Room.

PROBLEM SITUATIONS AND REMEDIES

Poor Performance

There are three main classes of problems that can be experienced in training detector dogs. They are:

a. Missed targets - Failure to detect one or more of the S+ odors.

b. False sits - The dog sits when there is no S+ odor in the area.

c. Poor search behavior -

(1) Movement - Dog does not move around the area to be searched.

(2) Detection - Dog moves around the room to be searched, but does not sniff at objects with which he comes into contact.

There is a variety of reasons that may account for one or the other of these problems. The following is a list of some of the more likely causes associated with these problems and a brief discussion of each problem as well as some clues as to how to deal with these problems when they arise.

Perhaps the most basic rule to follow if the dog begins to perform poorly is to revert to a simpler task; once the dog is performing well, gradually make the task more difficult. If the dog begins to make errors and is allowed to continue in the same task, its performance will probably continue to deteriorate and a great deal of remedial work may then be required to recapture the dog's previous level of performance.

Missed Targets

Causes - If the dog fails to sit when the S+ odor is in the vicinity, the most likely reason is that the odor has not been detected. No dog will always detect all S+ stimuli which have been planted; however, a well-trained and well-maintained dog should detect a high percentage of S+ stimuli. In addition, a certain percentage of correct detections and, therefore, rewards must be programmed into the dog's daily working sessions. There are two ways to insure that extended periods of searching will not go unrewarded:

a. Make the item to be detected very easy to find, and

b. Make the plants more difficult to find but place several of them in the area to be searched.

If it is possible, place several difficult S+ plants in the area. Detecting difficult plants requires good search behavior and thus the dog is more likely to be rewarded (by a detection) for good search behavior when the S+ stimuli are relatively difficult. Missed targets can also result from the dog learning to rely on cues other than those of the explosive material itself; when these false cues are not available, the dog fails to detect the odor.

Marking - There is always the possibility that the dog will "mark" the S+ stimuli. That is, the same S+ stimuli are reused and the dog may leave a sign by licking or salivating on the material that it can detect on subsequent trials, so that it may be responding to something other than the S+ odor itself (Figure 27).

This will result in missed targets when new stimulus materials, to which the dog has not been exposed, are used. If the detection rate is approximately the same for both the old and the new S+ stimuli, it can be assumed that the dog is responding to the S+ odor. It is essential to replace the old S+ materials with new samples frequently. This will assure that the dog is responding to the S+ odor and not to marked stimuli.

Following - When several dogs are trained to search for the same set of S+ samples, some dogs may learn to follow others. When an area is programmed for the dog to search, it is most convenient to test several dogs on the same program, but this entails the risk of having one dog learn to follow another and, therefore, miss targets that may not have been detected by the other dog. Dogs can apparently detect a place where other dogs have sat. The odor of food is also present in the vicinity of the hidden S+. Even if the dog is not depending entirely on either of these two extraneous cues, it may use either or both to orient to the general vicinity of the S+. If it is necessary to run more than one dog on the same program, alternate the order in which the dogs are run. If a particular dog is run first on one session, it should be run last the next session. The S+ stimulus can be moved if the programmer is certain there will be no residual odor. For example, if an S+ is hidden in a box, the box could be moved to another location in the room. If a particular dog does well when it follows another dog and does poorly when run first or when the position of the S+ is changed, there is a strong possibility that this dog is following another dog. Steps should be taken to eliminate the opportunity to follow.

Human Odors - The sensitivity of the dog to most odors makes it possible to train it to detect almost any type of odor. Dogs are especially sensitive to the odor of humans. It is well known that dogs can be trained to detect human odors many hours old. Training problems can arise because of this keen sensitivity.

Contamination - There is always the possibility that the dog is detecting the odor of the person who prepared or planted the S+ instead of the actual S+ odor. This is especially troublesome if the S+ odor is weak. There is no great cause for concern if it is the S+ odor plus any human odor that the dog responds to, as this will be the case in the detection of an actual bomb. The real problem arises if the dog is responding to a particular human odor which is necessarily associated with the S+ odor and not to the explosive odor. It is easy to check to see if the dog is responding to the explosive odor rather than to the human odor by simply having a different individual prepare and plant the S+ and S- stimulus packets.

Other Contaminating Odors - The S+ samples often absorb odors of materials with which they come into contact. As the contaminating odors are often far more potent than the S+ odor, the dog learns to sit to the contaminants and to ignore the S+ odor component. This shows up when the old S+ samples are

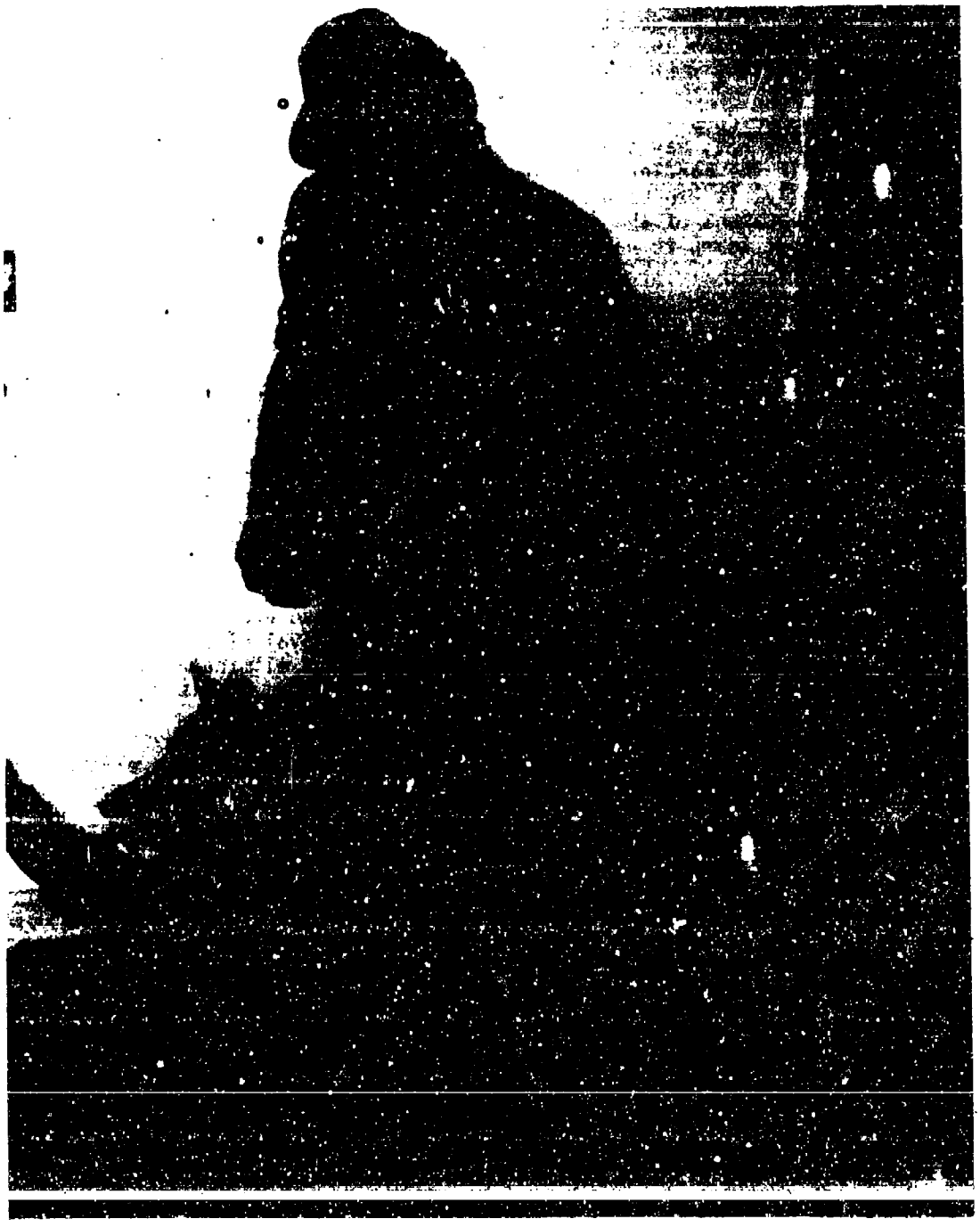


Figure 27. A Dog Marking an S+ Jar by Licking It.

replaced with new ones. Frequent replacement of old S+ samples will greatly reduce the opportunity for the dog to learn to respond to contaminating odors and will also reveal any such learning before it can become firmly established.

Unintentional Handler Cues - Any behavior on the part of the handler, whether it is intentional or not, may affect the dog's behavior. Handler cues will become a problem if the handler knows where the S+ is hidden in the area being searched. Generally, it can be assumed that if the handler does not know anything about the placement of the S+ and S- stimuli, he will not cue the dog, and the dog will not learn to watch the handler for cues.

False Sits

This is a somewhat more complicated problem as there is a variety of conditions which may result in the dog sitting in the absence of an S+. When the false sit occurs, do not praise or give food to the dog. Investigate the reason for its false sitting so that the necessary precautions can be taken to see that the same problem will not recur.

It is possible that the handler may do something to cause the dog to sit. In this case, do not reward, but repeat the command SEARCH. In most instances the dog will again begin to search the area until a detection is made.

If it is clear that the handler did not prompt a false sit, punishment by time-out may be given. The dog should be staked out in an area removed from the training area and left alone for some time. The removal of a dog from a setting which affords social contact with the handler and eliminates the opportunity for the dog to earn food is punishing to the dog. This time-out treatment has the same effect as physical punishment in eliminating unwanted behaviors, but it has none of the harmful effects associated with physical punishment. This procedure has been found to work especially well in eliminating false sits.

There are several factors which may cause false sits. The following discussion gives some of the most common reasons:

Odor Contamination - Whenever an S+ packet is handled, some of its odor may adhere to the hands and may subsequently be transferred to other objects that are handled. Such objects are said to be contaminated with the S+ odor, and may be responded to by the dog, especially if the S+ has a strong odor or the dog has become highly sensitive to that S+. Since the handler ordinarily has no way of telling that the object is contaminated with the S+ odor, he cannot reward the dog for sitting to it. Hence, every time the dog sits to a contaminated object he is actually being trained to ignore a very weak S+ odor, which is just the opposite of what the handler desires. For this reason, every effort should be made to avoid unnecessary handling of either the S+ or objects in the area to be searched.

Residual Odors - After a particular odor has been placed in a certain place and then removed, it should be assumed that the odor will remain for some time as a residual odor. After an S+ packet has been removed from storage, the odor that remains behind may last for days. Certain materials such as paper or

other porous materials may retain residual odors for an extended period. Be sure to completely air out any area where an S+ has previously been placed, but do not assume that residual odors are thereby eliminated. Residual odors can become troublesome if repeated sessions are conducted in the same area. Remember that a response to a residual odor is a correct response that should be reinforced just as if an S+ had been placed at that spot. The main problem here is that there is no way of knowing whether an S+ odor is actually present or not since the dog might have remembered the location from the previous day. The only good solution is to avoid running a dog where a residual odor may be present.

Odors Similar to the S+ - For any given substance that the dog has been trained to detect, there probably will be several other substances that -- to the dog -- smell much like the S+. The dog has not been specifically trained to ignore such "false" odors and is, therefore, likely to react to them as S+ odors. If the dog is punished for what it regards as a correct response, the dog's future tendency to sit to "real" S+ odors may be weakened, impairing its usefulness in detecting the S+ substance. On the other hand, rewarding the dog for responding to such odors will increase the range of false odors to which it will respond. The problem is similar to that of residual odors, but is more complex since there is no way of insuring that the "false" odors will not be present. A sit to a suspected false odor should be treated like a sit that was accidently evoked by the handler by neither rewarding nor punishing the dog, but by repeating the search command. If the dog repeats the sit response, remove the object from the area. A description of the object should be recorded and, if possible, the object should be tested with other dogs.

Poor Search Behavior

If the dog is not searching properly, it will ordinarily be detected by observation. Slow or ill-directed movement is one type of poor search behavior, as is failure to sniff the area. Both of these faults may occur together. Good movement is more often found with poor sniffing behavior than poor movement with good sniffing behavior.

Another way to tell if a dog is searching properly is to evaluate the percentage of S+ detections. Although there are reasons other than poor search behavior which may account for a poor S+ detection rate, the most likely explanation is that the dog is not searching properly.

Whenever a dog is not searching properly or is not making a reasonable number of detections, it should be removed from the working situation. Do not continue to work a dog if it is apparently doing poorly. After removing the dog, attempt to determine the possible cause of its poor search behavior and take steps to eliminate the problem before returning it. The following are the most frequent causes of poor searching:

a. If the dog appears to be sick, it should not be worked. At times, however, the dog may be sick and yet not display any observable signs. Poor search behavior may indicate that the dog is sick and that proper medical steps should be taken immediately.

b. If the dog becomes frightened or distracted, its search behavior will be interrupted. Simply talking to a dog is the best way to reassure it. If

the handler becomes aggressive or attempts to force the dog to continue to search, the situation becomes worse. Fear is originally established through punishment. Anything associated with punishment, such as sharp verbal commands or jerks on the dog's leash, will increase its fear and make its search behavior even worse.

c. If the dog becomes fearful of something in particular, the following method is suggested to reduce the fear. Suppose the dog is afraid of loud noises. Bring the dog very slowly to a noise source, while petting it and talking gently to it. As the dog is brought close to the noise, give it food. Do this very gradually and without forcing the dog to move toward the noise source.

d. There will be times when the dog will become fatigued during the training session. It may generally continue to search but its efficiency will be impaired. This will most likely result in the dog's walking around the room but failing to sniff or bring its nose close to objects. If signs of fatigue are noted, give the dog a short rest and then resume the training session. A single search session should not exceed one hour and should be less if the dog shows signs of fatigue.

The best procedure is to avoid working the dog long enough for its behavior to be effected adversely. For extended search periods, this means allowing the dog short rest periods and access to water periodically before any signs of fatigue, thirst or poor searching appear.

DETECTOR TEAMS, OPERATIONS, AND TRAINING SCHEDULES

Handler Training

The first prerequisite for a handler is that he be a volunteer and also be a qualified dog handler. Armed Forces schools capable of producing dog handlers are located at Fort Benning, GA, and at Lackland AFB, TX.

Another prerequisite is that the handler should attend a basic explosives handling course prior to beginning training. Such courses are normally taught by Explosives Ordnance Disposal (EOD) activities.

The Training Cycle

Handler Assignments - It is desirable for the handler to accompany his dog through all phases of explosives detection training. This enables the handler to work directly for the trainer and to learn all necessary procedures for maintaining his dog's proficiency. Since the dog is pretrained, the handler can concentrate more on technique than on basic principles.

Training Topics - The training of an Explosives Detection Dog Handler includes the following major topics:

a. Basic Knowledge

b. Programming Techniques

c. Maintenance Training

d. Handling Techniques

e. Operational Employment

f. The Detector Team

Basic Knowledge - By going through detection training with his dog, the handler gains the basic knowledge of the complex training required to produce an effective explosives detection dog. He learns the problem situations that may develop and how to correct them.

Programming Techniques - The handler must learn that correct programming technique is the key to effective training.

Maintenance Training - Handlers are taught that maintaining their dog's proficiency is as important as maintenance of a rifle or vehicle in combat. Only through continuous maintenance training can handlers keep their dogs at operational proficiency and correct deficiencies as they arise.

Handling Techniques - The majority of the handler's training is concentrated in this area. As with other detection systems, the dog is effective only if it is "operated" and employed correctly. Handlers learn the tricks and techniques of room and building search, where to look, what to look for, etc.

Operational Employment - By training in environments closely simulating operational conditions, handlers learn to effectively employ their dogs under the situations and stresses that would actually be present on an operational mission.

Detector Teams

The detector team consists of three persons: a Team Leader/Programmer, two handlers and two dogs. Team personnel should each be trained to program as well as to handle the dogs. Three are required so that leaves, passes and emergency absences will not reduce operational efficiency. Handler and team leader/programming duties can be rotated among the team members.

Team Leader/Programmer - Under conditions of an actual bomb search, the initial duty of the Team Leader/Programmer is to estimate the probability that a bomb may be located in a given area. A suspect area will be marked and searched immediately. If no one area is particularly suspect, then the Team Leader/Programmer will establish search priorities for the areas to be searched and mark them with strips of red, yellow or blue paper.

a. A red paper strip indicates a high priority area that should be searched first. An example of a red area would be a restroom, the maid's or janitor's closets, maintenance rooms or facilities and areas in which it would be time-consuming for humans to search, such as libraries and lockers. Places and objects which are easily accessible to visitors are high probability areas and would be marked red (Figure 28).

b. A yellow paper strip means an area of low priority. A yellow area will be searched as time allows.

c. A blue paper strip indicates an area that can be bypassed.

d. The Team Leader/Programmer must make the decision as to how the area is to be searched. Based on the size (number of floors, rooms, etc.) and complexity of the building, the Team Leader/Programmer will plan and direct the route that the team will follow.

e. S+ samples must be placed by the Team Leader/Programmer in the search area. The placement of the S+ samples is made during the initial investigation. The immediate area in which the S+ sample is hidden is thoroughly searched out by the Team Leader/Programmer prior to the placement. This is done to insure that no actual bomb is located where the sample is placed. Otherwise, the dog's response to the actual bomb could be confused with the response to the sample. A tape recorder would be helpful to record the location of each S+ sample. Additional information needed for later evaluation of the dog's performance could also be recorded.

f. After programming a portion of the area to be searched, the Team Leader/Programmer returns to the dog and handler and accompanies them as they search the area. When the dog sits, the Team Leader/Programmer says YES if he has hidden an S+ there. If he has not planted S+ where the dog is sitting, a possible bomb is indicated and appropriate steps are taken. For each room

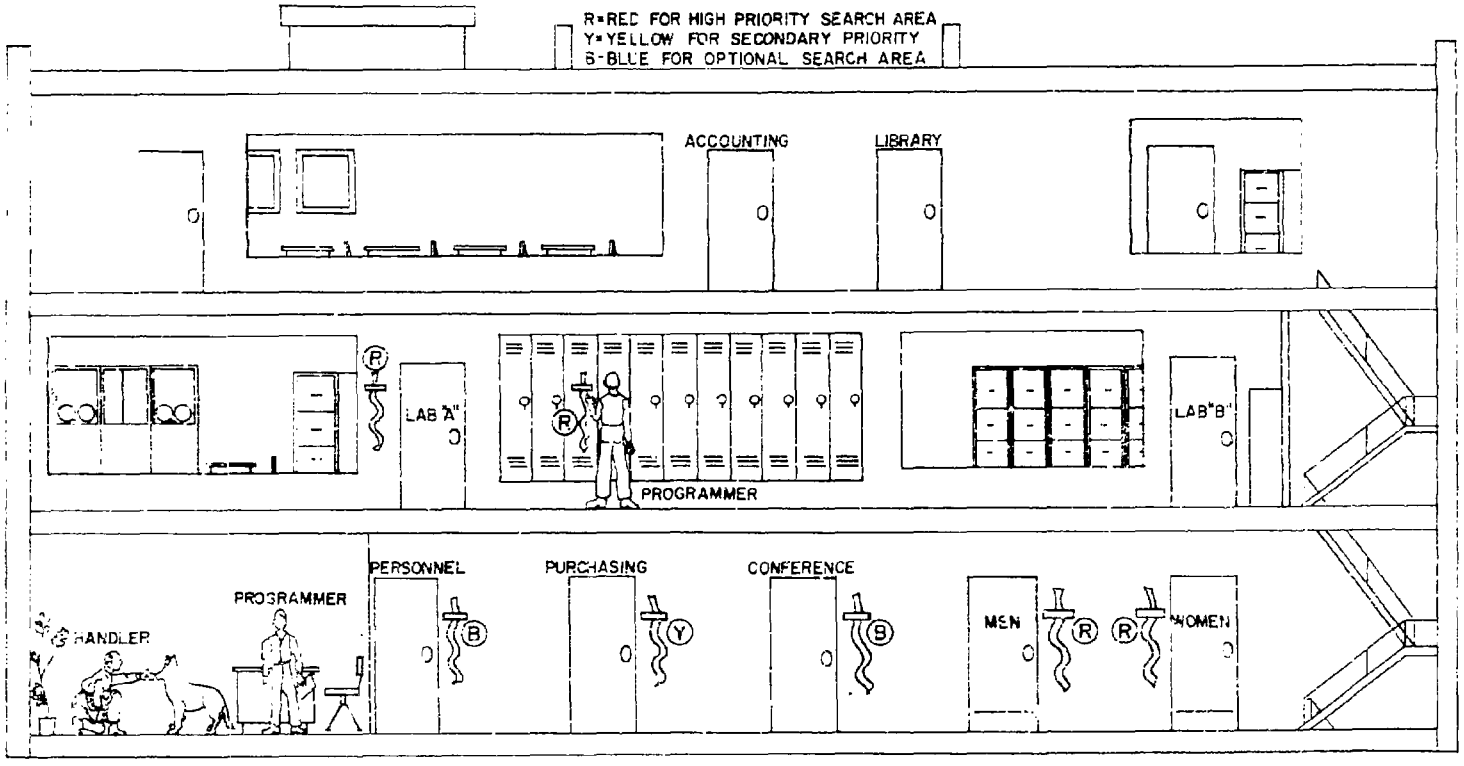


Figure 28. Evaluation Exercise in Progress. Note Red Markers on Wall Lockers and Restrooms.

the Team Leader/Programmer records detections, false sits and time spent searching, as well as any information which will be needed for later evaluation of the session. While the rooms which have been programmed are being searched, the third team member can program the next set of rooms.

g. A basic rule for determining the number of S+ samples to be programmed in a given search situation is to emplace the number estimated to be required to keep the dog actively searching, plus a very few additional ones "for good measure." If the program is too lean (too few S+ samples), the dog will not maintain good search behavior. On the other hand, if the program is too rich (too many S+ samples), a great deal of time will be taken rewarding the dog and the dog will quickly become too well fed for effective search motivation. The reason for the few extra S+ samples is that too rich a schedule can do less harm than too lean a schedule. The decision on how to program a particular area will be the responsibility of the Team Leader/Programmer, and how effectively he performs this duty will be crucial to keeping the dog working efficiently. If there is any doubt about the program, or if the dog's detection rate is decreasing or poor search behavior is shown, enrich the program (emplace more S+ samples) and then gradually make the program leaner.

h. S+ samples should be emplaced in all types of sessions, including operational sessions. The major reason for emplacing S+ samples is to keep the dog working at maximum efficiency. It is rewarding for the dog each time it detects the S+ odor and if there were no S+ stimuli to detect, searching behavior would gradually deteriorate. If the S+ samples were emplaced in all work sessions except operational sessions, the dog would eventually become proficient in all types of sessions except operational sessions. A second purpose is to evaluate the dog's efficiency on a given session. This is especially important for those operational sessions in which no bomb is found. There, the detection of emplaced S+'s indicates that the failure to detect a bomb was probably due to the absence of a bomb, rather than to any lack of efficiency of the dog.

i. The Team Leader/Programmer initially locates a control area to be used as a base for the operation. This then allows him to proceed to his preliminary investigation and the flagging and planning of the route to be taken by the handler and dog.

(1) While the Team Leader/Programmer outlines the route (which room or area and in what sequence); the way the room is searched is the responsibility of the handler. It is better to go into many rooms briefly than to spend all the time available in a few of the rooms, since a dog has a good chance of finding a bomb in the area rather quickly. The handler and his dog quickly search through the room and specifically check the places marked by the Team Leader/Programmer as most likely to have an S+ present before leaving.

(2) As the dog has been trained to work on or off leash, the handler will choose which method with which to conduct the search most effectively. In either case, the dog should be allowed to work at its own pace, even if the pace often appears too fast. The handler can direct the dog to return and search a particular area of the room. The handler directs the dog by moving to the section or object and giving the search command. He should be

careful to use this procedure sparingly or the dog will learn to wait for directions instead of continually searching the entire area.

pes of Exercises

There are three types of exercises that trained detector dogs will perform:

a. Operational Exercises. These exercises represent actual bomb threats. Records of the dog's performance and of any special problems will be kept by the team.

b. Evaluation Exercises. These are as similar as possible to the operational exercise (actual bomb search) up to the point of including the hiding of an actual bomb (without arming device). The bomb must be planted by a person other than a team member.

c. Maintenance Exercises. These are training exercises. Deficiencies noted in the dog's performance will be systematically evaluated during these sessions and corrective procedures will be carried out.

Figure 28 shows an evaluation exercise in progress in a research installation. The Team Leader/Programmer, Handler No. 1 and dog are working the first floor while Handler No. 2 is marking the second floor. The dog is being rewarded for finding an S+ sample hidden in the lobby. As the handler does not know the location of the S+ samples, the Team Leader/Programmer who marked the floor and emplaced the S+ samples must accompany him on his search. Handler No. 2 will join Handler No. 1 in searching the second floor while the Team Leader/Programmer marks the third floor. Note the red markers being placed on the doors to the high traffic areas (such as restrooms) or those time-consuming for people to search (wall lockers).

Suggested Training Schedule

The following training schedule should be used as a general guide for dog training. REMEMBER THAT THE SEQUENCE OF THE PHASES OF THE TRAINING PROGRAM AND THE PROPER ADVANCEMENT OF THE DOG THROUGH THE PROGRAM IS OF MORE IMPORTANCE THAN THE EXACT TIME A DOG SPENDS LEARNING ANY GIVEN PHASE. A 100% RESPONSE FOR AT LEAST ONE TRAINING SESSION IS MANDATORY BEFORE ADVANCING A DOG TO THE NEXT PHASE OF TRAINING.

TABLE 1. SUGGESTED TRAINING SCHEDULE

PHASE OF TRAINING	SUGGESTED DURATION	PAGE NUMBER
ANIMAL SELECTION	-	13
CONDITIONING TRAINING	THREE WEEKS	14-21
Scent Association - Phase I	One-Two Days	18
Scent Association - Phase II	One-Two Days	18

PHASE OF TRAINING	SUGGESTED DURATION	PAGE NUMBER
DISCRIMINATION TRAINING	THREE WEEKS	27
Four-Choice	One and one-half weeks	27-30
Six-Choice	One and one-half weeks	31-37
ADDITIONAL EXPLOSIVES RECOGNITION TRAINING	ONE TO FOUR WEEKS (DEPENDING ON TYPE AND NUMBER)	37-43
ROOM SEARCH TRAINING	THREE WEEKS	46-52
OPERATIONAL TRAINING	ONE TO THREE WEEKS	63-67

Sequencing and Scheduling of Dog Training

It is impossible to establish a firm schedule for a dog to learn a specific task. Each of the dogs in the program will have its own individual behavior patterns and it will be necessary to adjust their training schedule accordingly. Some dogs will make slow but steady progress through the entire training program, others will advance through the program as fast as the trainer can advance them, and others will bog down in discrimination training or room search for a few additional days. In addition, a dog's progress through the program will also vary from day to day depending on the dog s health, interest and attitude. Consequently, on any given day the trainer should be prepared to find each dog in a different stage of training. THE TRAINER SHOULD FIRMLY RESIST THE NATURAL URGE TO "EVEN THINGS UP" BY HURRYING A SLOW DOG ALONG TO THE NEXT STAGE IN TRAINING.

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